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REPORT

OF THE

ENTOMOLOGICAL DEPARTMENT

OF THE

New Jersey
Agricultural College Experiment Station,

BY

JOHN B. SMITH, Sc.D.,

For the Year 1899.

CAMDEN, N. J.:
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With compliments of
John B. Smith

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REPORT OF THE ENTOMOLOGIST.

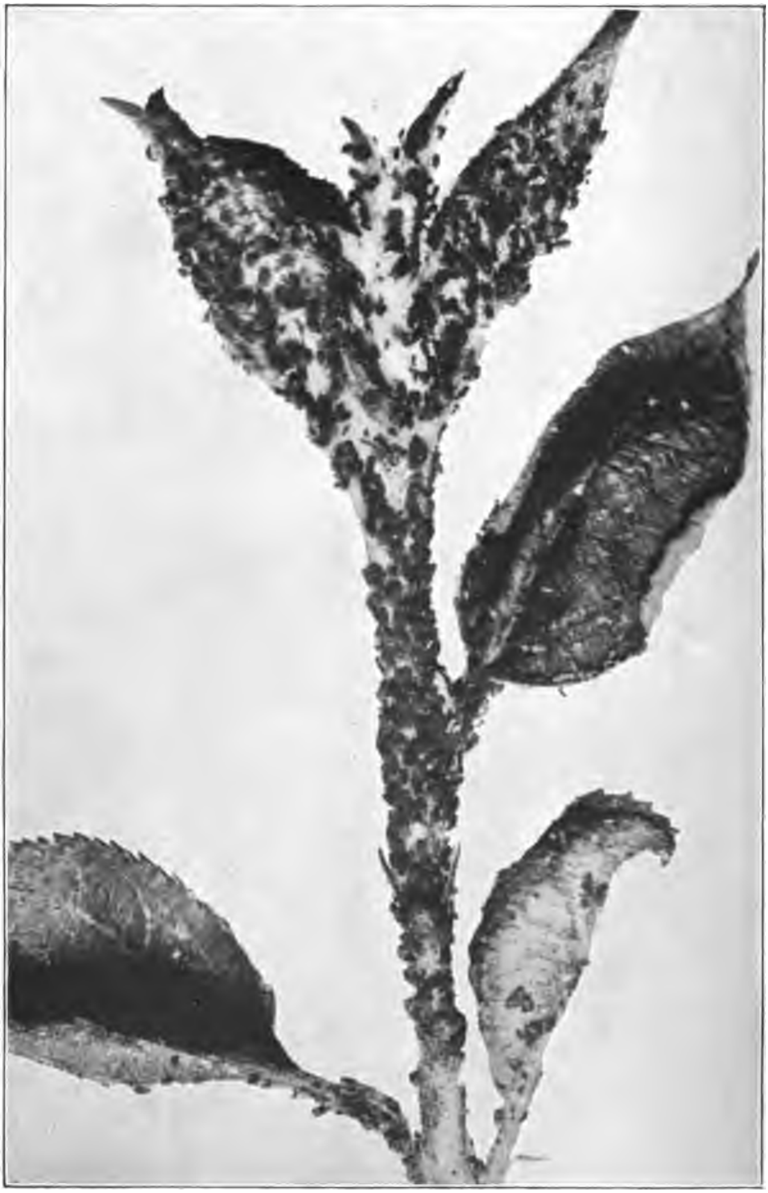

Fig. 1.

Tip of an Apple Twig showing Injury Caused by Plant Lice. From an original photo.

REPORT OF THE ENTOMOLOGIST.

GENERAL REVIEW.

The season of 1899 was characterized in the matter of climate by a long drought in late spring and early summer, and by abundant rains in most localities later on. The spring drought, joining to the unusually dry weather of the fall of 1898, favored the development of certain plant lice, among which a species attacking the pea became conspicuously destructive, and this was the notable event of the season from the entomological standpoint.

The intense cold during the winter of 1898–99 raised hopes in some quarters that it might prove as destructive to insect pests as it undoubtedly was in some sections to certain fruit buds, but such anticipations were not verified. The pernicious scale, for instance, survived unscathed on trees on which all fruit buds were killed, and it may be safely concluded that no temperature likely to occur in New Jersey will be likely to affect this species adversely. In fact, insects once completely dormant resist almost any degree of cold, the frequent changes from warm to cold being much more fatal.

Plant Lice.

Several species of these insects became unusually abundant this year, while others which, like the melon louse, form a standing menace were not especially troublesome. In a few localities some injury was reported on cantaloupes; but it came late in the season, when prices had broken because of a glutted market, hence the money-loss was not serious in any case.

On apples plant lice were abundant in many localities, some varieties suffering much more than others. The injury was chiefly on young trees and on those yet in the nursery rows. These nursery trees will be quite generally distributed throughout the State during the winter, and it will need attention on the part of the orchardist if he wishes to avoid injury next spring. In this species the eggs winter on the twigs, as close to the buds as the insects can get them, so long as there is room there, and anywhere else if there is not. They are also very apt to lay them in little slits or other injured spots on the trunk, hence pruning should be careful, all the cut wood should be burnt, and in early spring, if lice appear on the tree, they should be at once treated. This insect formed one of the subjects of study during the summer and a bulletin on it is in course of preparation.

Quite a number of plant lice were noticed on peach trees late in 1898, and in the spring of 1899 young trees showed a considerable infestation. Fortunately the trouble did not last long and by the end of May was practically over.

Plums and cherries suffered much less than usual, though locally, there was some curling of the leaves. Yet, taken as a whole, the season was favorable for these fruits, excellent crops having been harvested in many sections. An encouraging feature is the comparatively few specimens seen during the latter part of the season.

Early in July the appearance of plant lice in some numbers on potatoes and tomatoes caused a little scare, locally; but I have no reports of any serious injury on those crops.

On tulip trees plant lice became extremely abundant in parts of South Jersey, and there they were a little injured, many of the leaves being killed, but here also the natural checks obtained control before the end of the season.

The really characteristic feature of the year was the destructive increase of a species of this sort in pea plants.

The Pea Plant Louse.

In my report for 1898 I noted on page 379 that "after the middle of September late peas on the College Farm became completely covered with aphids, and the plants having been retarded by adverse weather conditions were now so much exhausted by the insects that the crop was a complete failure. It is very probable that this infestation was more widespread, but was not reported by correspondents."

This suspicion proved to be well founded, and, worse than this, the insect re-appeared in the spring of 1899. The late fall of 1898 was unusually dry, a condition adverse to the plants and apparently favorable to the insects. The spring of 1899 started in with a long drought, so that similar conditions existed.

Newspaper notices reported plant lice as injuring peas in Maryland and Virginia long before they became noticeable in New Jersey, and as late as June 12th I received letters from two of our growers in Monmouth and Burlington counties, asking for information concerning the insects; but stating also that, while some lice were present on their fields, they occurred in very small numbers, and it seemed unlikely that they could prove injurious.

June 26th, Mr. A. Brakeley, of Bordentown, who had 460 acres in peas, and had not found anything of dangerous appearance June 14th, wrote: "The green lice have made great havoc amongst my peas; cold weather and wet weather, neither seem to make a difference. Yesterday I cleared a field of peas that was badly infested, and to-day I find them traveling for a tomato field about fifteen feet from them across a vacant space. They are on grass, weeds and everything on the road."

July 6th, Mr. Brakeley wrote concerning the actual amount of injury caused by the insects: "As to the percentage of damage done by the pea lice, it is hard to tell how much is chargeable to lice and how much to drought. On our early peas we saw nothing of them. They began to show about the middle of second earlier, and before we were done with that had spread over all the balance of them, but I think did them comparatively little harm, as they came too late, but may have lessened their filling out. On the late, the first eighty acres had them more or less all over, but did not destroy anything, though no doubt they prevented perfect filling out. On the next seventy acres there was much that was totally destroyed by them, and all greatly stunted and damaged. Got only about one-fourth to one-third of a crop. The next twenty acres we will gather on Saturday, and will not get enough to pay for gathering. The remaining forty-seven acres I have abandoned as worthless. The great question with us now is, are they likely to repeat it next year?"

September 12th, Mr. Brakeley noted on a patch planted for observation that the insects seemed to be drying up, and specimens sent me on that date proved to be infested by a fungus which Dr. Roland Thaxter, of Cambridge, kindly determined for me as *Entomophthora aphidis*, the usual form occurring on plant lice.

Mr. Joseph Brakeley, of Freehold, grew 1,000 acres of peas in 1899, and on June 12th could find only a few lice on the fields examined, but on the 28th of the same month he finds that "the plant lice have done me great damage here since writing you in the matter. The later plantings of my earlier varieties have been totally destroyed. They start in on the northwest side of the field, apparently, as those sides are totally destroyed, except on two fields, where all have been taken. The opposite side will only be partially injured. Spraying is not effective. Where the spray comes into contact with them they give up, but it is impossible to get them all or anywhere near all."

The loss in this case amounted to the crop from about 100 acres, or 10 per cent. of the entire planting.

Other complaints came from Burlington county during the first half of July, and in all cases the injury was serious, amounting in the majority of instances to the entire crop.

Mr. J. A. Kelsey informs me that on the College Farm the early crop of green peas under his charge matured without injury, and no late crops were planted.

Prof. Voorhees states that the early fodder crops containing peas were all right, but the later plantings were much infested, while the fall crops of oats and peas were practically ruined.

It is notable that until the middle of June little or no injury had been caused by the insects, and that between that date and the first part of July they increased so rapidly as to simply overwhelm the plants. It is also worthy of note that the fall of 1899 was as wet as that of 1898 was dry, yet on the College Farm the fodder crops were quite as much injured.

Curiously enough this pea louse proves to be an undescribed species, an insect that until last year (1898) had escaped the notice of even the entomologist, and certainly had never, in history, caused anything like the injury chargeable to it in 1899. It was even more destructive in Maryland and Virginia than it was in New Jersey, and, as Prof. Johnson, of the Maryland Station, had announced his intention of studying the species, nothing was done by me, to avoid unnecessary duplication of work. He has given the manuscript name of *Nectarophora destructor* to the species, but has not as yet, at this writing, published either the life history or suggested methods of control.

As the matter stands at present, the only advice possible is to plant no late peas next spring, at least not as a main reliance. Judging from what experience has been had, the insects will not become seriously injurious until after June 15th, and crops to ripen not later than this may be planted with a reasonable degree of safety.

It is by no means uncommon for an insect theretofore unknown to spring into prominent notice as the pea louse has done, but in almost every instance a brief destructive career is followed by a reversion to the old obscurity when the check, whose removal allowed the undue increase, becomes re-established. When this will

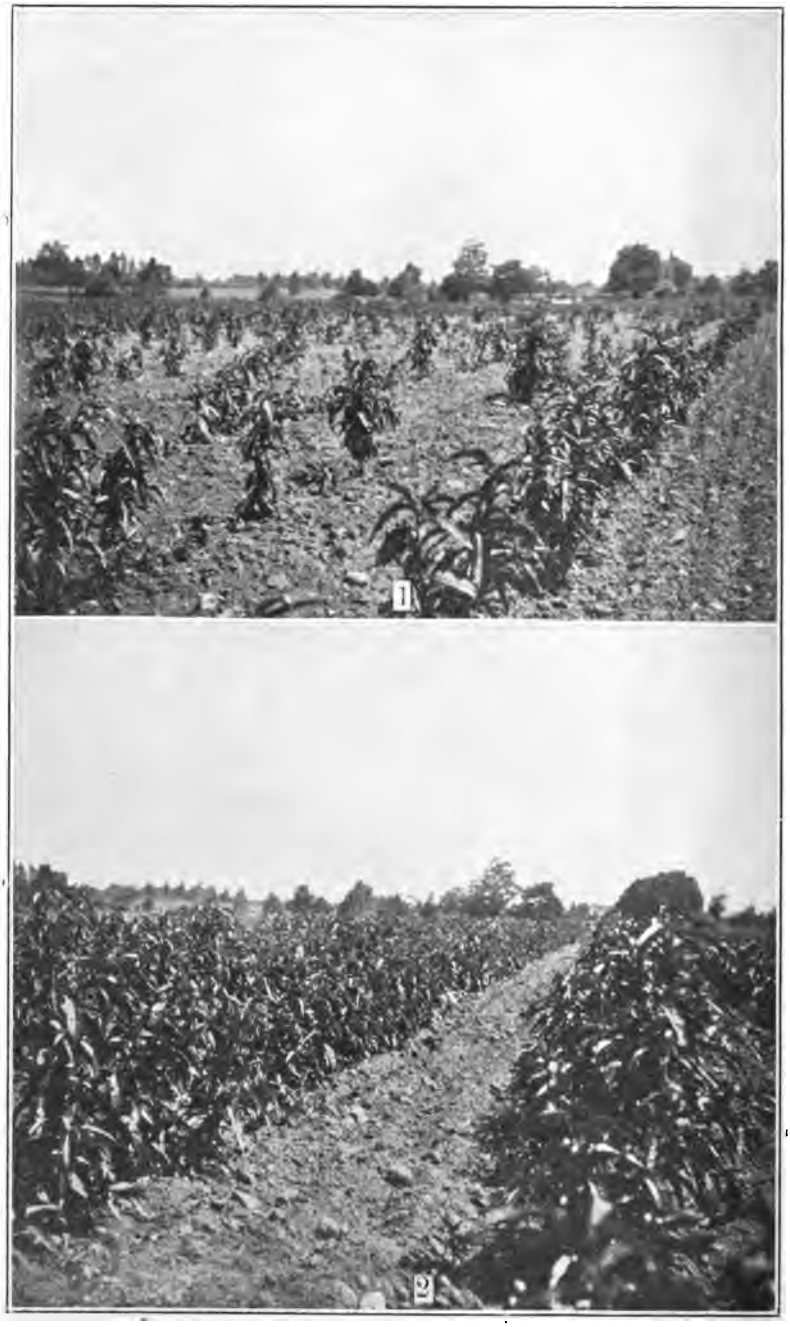

Fig. 2.

Work of the Peach Thrips: 1, Peach Nursery After the Thrips had Disappeared in June; 2, Peach Nursery, showing Rows Sprayed June 9th with Undiluted Kerosene. Photo. made June 19th.

occur in this instance it is impossible to say, because I do not know all the facts. Conservative planting of late peas is advised for the present, until a year's freedom from attack proves it safe to return to the usual method. Insecticides usually employed against plant lice are impractical in a case like this, where any large acreage of peas is grown. In the garden, or on a small scale, tobacco or weak soap washes will prove effective.

Peach Thrips.

For two or three years past I have noticed in nursery examinations of peaches a varying number of trees that had branched low, the leader having the tip dead and dry, and in some cases the lower branches were in the same condition. I have been asked at such times what caused this injury, which was described as a dying of the heart during June; but it was, of course, impossible to make even a plausible suggestion months after the injury was caused, especially as no one had ever seen any insects on the trees that could by any chance be connected with this sort of result.

June 8th, Mr. Edwin Allen, who has a nursery not far from New Brunswick, called on me with some examples of leading shoots which had been killed, and he stated that a considerable percentage of his trees were completely ruined. I could find nothing in the specimens brought in, and visited the nursery on the 9th. Mr. Allen informed me that this sort of injury had been noticed for several years, but never so bad as now, and, as almost 50 per cent. of the trees had the tips of the leading shoots killed in that part of the nursery where the examination was made, the matter was certainly serious enough. In the tips that were entirely dry nothing at all was found; in every one of those that were yet moist, from three to five minute immature Thripids were discovered.

Only one winged or adult specimen was seen, and this escaped. We were at this time in the midst of the droughty period, and only very local showers offered occasional relief. I advised Mr. Allen that only the thorough breaking of the dry spell or a very heavy cold shower would check the injury, insecticides being impractical in a case like this. Nevertheless, he concluded to try the effect of undiluted kerosene on two or three rows and had the machine working before I left. I gathered a number of the infested tips, but as it was late when I reached home, left their examination until the next day. At that time I could not find a single decent example. Every one had been crushed in the drying gum or had disappeared to parts unknown. Meanwhile there had been a very heavy and very local shower, of which the nurseries got a full share, while scarcely a drop reached my experiment orchard.

When, on the 19th, I visited the nursery again, not a specimen of the Thripid could be found, and the trees were making a good growth of laterals. In almost all the nurseries visited by me during the fall of 1899 a large percentage of the trees was stunted in a similar manner and, I doubt not, by this same insect.

During the winter of 1898–99 Prof. Johnson, of the Maryland Station, referred to what appeared to be a similar injury in Maryland; but this was charged to a mite. Making inquiry into the matter, Prof. Johnson assured me there could be no chance of error, and, while the injury caused was almost exactly identical, the culprit in Maryland was undoubtedly a mite, and no Thripid had been found in the injured tips at any time.

Prof. Wm. B. Alwood, of the Virginia Station, of whom also I inquired, wrote, "I have worked on this Thrips, which attacks the small buds of peach, ever since 1891, but, unfortunately, have not been able to stay the whole period in the nursery myself or keep an assistant there; hence we have not completed the full data relating to this attack, but we are certain that it is a Thrips, and most likely *tritici;* in fact, I have it so determined."

The complete life history of the attack on peach being, therefore, unknown, no final suggestions concerning treatment can be made. The species of Thrips, as a rule, delight in dry weather, and their attacks are always most severe in a season of drought; hence if there is any feasible method of mitigating this drought, that would be the best remedial measure. Very liberal drenchings with water would probably be as good a way to destroy the insects as any that we have. Another, perhaps more practical, suggestion is to get as good an early growth on the plants as possible, so that when the almost inevitable dry spell of late spring makes its appearance the shoots should be long enough to make a trunk as high as it is usually left now-a-days. This can be done by having the ground in favorable condition and employing a little quick-acting, stimulating fertilizer, including in it some nitrate of soda.

Orchard Insects.

The usual pests have not maintained themselves so fully during the past season as in some other recent years. A fair crop of plums and similar fruits was made despite the curculio, even where no measures of any kind were adopted to keep it down.

Apples were in most localities clean and very free from "worms," even where no spraying was done; but, on the other hand, the codling moth attacked pears more generally than ever before in my experience, and there seemed to be a considerable second brood that passed the apples by in favor of the pears. In two large Burlington county Keiffer orchards a great many pears became infested in late August and September. In Gloucester county I found a similar case, and in my own little experiment orchard nearly every pear on trees 15 and 16 became so wormy that I decided to take them off long before they were ready to come off normally.

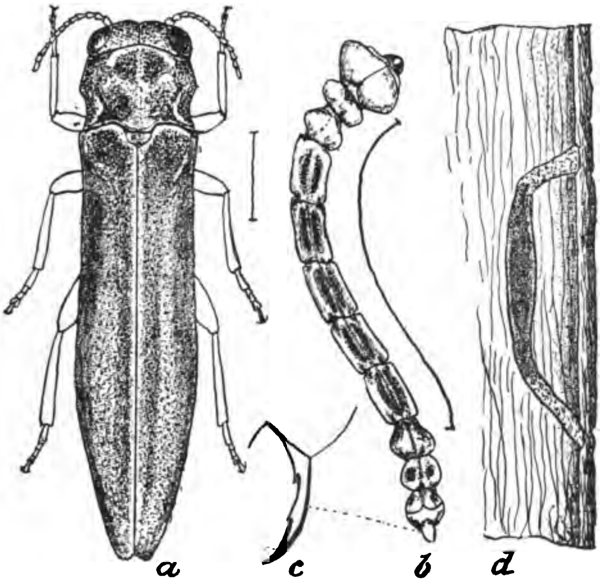

Fig. 3.
The Sinuate Pear Borer: *a*, beetle; *b* larva; *c*, its anal fork; *d*, pupal chamber with pupa in position; *a*, *b*, *c*, enlarged.

The pear psylla was noted on several occasions in small numbers, and a few specimens now form part of my menagerie in the Experiment Orchard.

In the last report I noted finding the *sinuate pear borer* in a nursery in Middlesex county. Since that time all the trees in the infested block have been destroyed, and I have been unable to find any other infested trees; but the insect has a wider distribution than was suspected. Several trees were found to be infested on the College Farm, and these have been either taken out or the borers have been cut out. A close watch is being kept on the others, that they may be attended to on the first indication that they are infested.

During the latter part of June I found a single example feeding on the leaves of a pear tree in my experiment orchard, over two miles from the nearest point where I had reason to suspect the occurrence of the insect. It is certain it did not develop where it was found, for none of the trees show any trace of the borer, while I am scarcely ready to believe in the flight of the beetle across the city from the College Farm for the special purpose of giving me the chance of capturing it in my own back-yard!

Pear slugs were troublesome in Atlantic and Mercer counties in June and again in August. In the latter month, at Lynnwood, Atlantic county, "it has been so destructive on some of the trees that there is practically no foliage left, and the trees have taken a brownish color. In some few instances nursery trees were rather severely checked in growth by these insects."

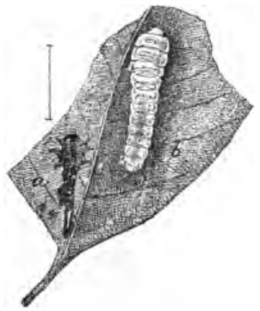

Fig. 4.

Pear Slug: *a*, last-moulted larval skin; *b*, the larva, somewhat enlarged. From Marlatt, Circular 26, Ser. 2, Div. Ent., U. S. Dept. Ag.

The plant lice occurring on orchard trees are elsewhere referred to. Their near relatives, the leaf-hoppers, were unusually abundant, locally, on apples, and the foliage was badly spotted, or even killed. The dry weather of the early part of the season was much to their liking, and, in fact, the summer as a whole favored their multiplication.

It must be admitted that they did not neglect their opportunities, and swarms of the hoppers occurred in apple orchards and in vineyards throughout September and early October.

Rarely have the yellow-necked apple-tree caterpillars been so abundant, and twice during the season swarms of them were seen, those occurring in September being much the most troublesome. In nurseries especially was their work noticeable, whole rows of trees being found completely defoliated when I was inspecting for San José scale. Young orchard trees were stripped in a number of instances, and so rapidly do the miserable creatures work when they are once started that two or three days will be sufficient to make a complete wreck of the foliage of a small tree. One of my small apples was almost stripped in three days during an absence from town, the young larvæ having escaped notice.

In one orchard the bag-worm made a good second to the previous species, and accomplished as clean a piece of work.

The fruit-bark beetle was found in a number of cases supplementing the work of the pernicious scale by attacking trees weakened by the former pest. It is absolutely indifferent as to the kind of fruit, apparently, my records embracing apple, pear, plum, peach, apricot and cherry!

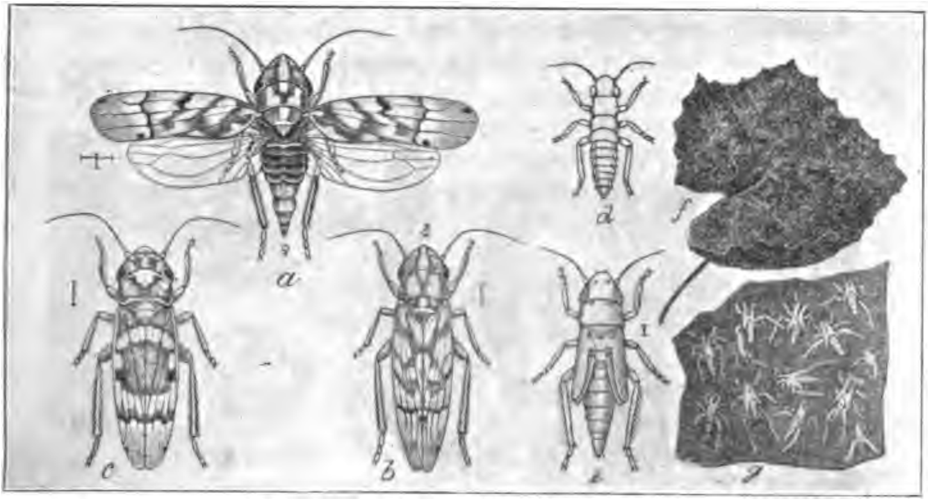

Fig. 5.

Grape Leaf-Hoppers: *a*, *Typhlocyba comes*, female; *b*, same, male; *c*, *T. vitifex;* *d*, larva; *e*, pupa; *f*, appearance of injured leaf; *g*, cast pupal skins; all save *f* enlarged. After Marlatt, Yearbook U. S. Dept. Agl., 1895.

The work of the Thrips in nursery peaches has been already referred to. Another pest that was noticed in some numbers this year is the *peach-twig borer*, an insect not heretofore referred to in these reports. My attention was not directed to it in 1898, but I found it on my own trees in May, 1899, in some numbers, as will appear in the

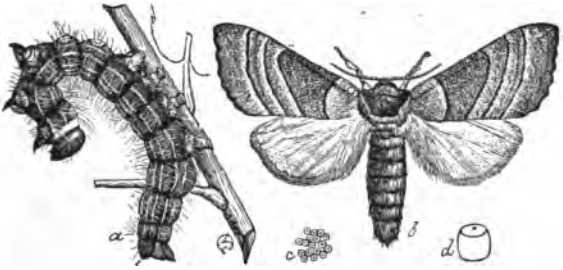

Fig. 6.

Yellow-Necked Caterpillar: *a*. the parent moth. *Datana ministra;* *b*, eggs, natural size at *c*, much enlarged at *d*. After Riley.

record of the Experiment Orchard. This induced me to note the conditions elsewhere, and I found a similar state of affairs. The injury was brief in duration, and all trace of it had disappeared before midsummer, no permanent harm having been done on the trees.

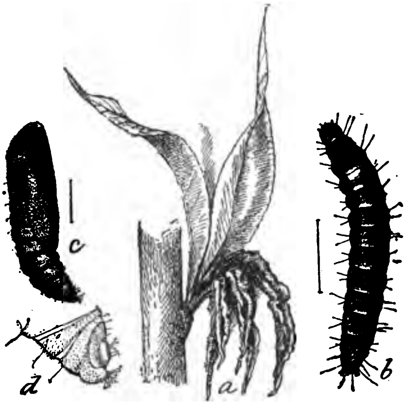

Fig. 7.

Peach-twig Borer: *a*, new shoot killed by the larva; *b*, larva; *c* pupa; *d*. tip of pupa; all save *a*. enlarged. Marlatt. Bull. 10, n. ser., Div. Ent., U. S Dept. Ag.

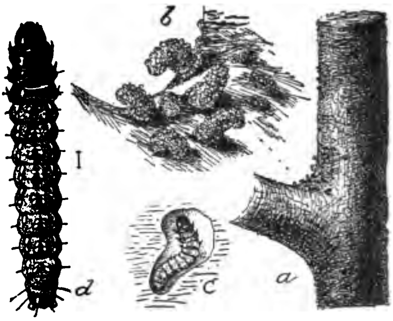

Fig. 8.

Peach-twig Borer in winter quarters: *a* twig of peach showing in crotch minute masses of chewed bark above larval chamber; *b* the chewed masses much enlarged; *c*. larval cell with contained larva enlarged; *d*, young larva from above, also much enlarged. Marlatt, Bull. 10, n. ser., Div. Ent., U. S. Dept. Ag.

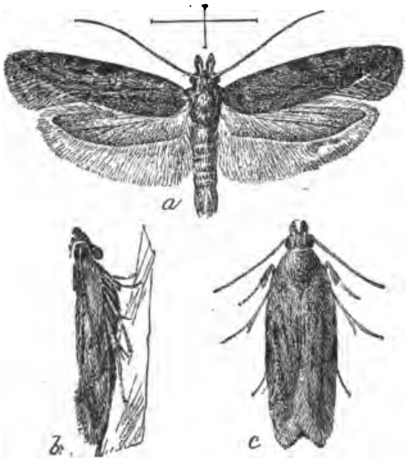

Fig. 10.

Anarsia lineatella, parent of the Peach-twig Borer: *a*, wings spread; *b*, *c*, wings folded and moth at rest; all much enlarged. Marlatt, Bull. 10, n. ser., Div. Ent., U. S. Dept. Ag.

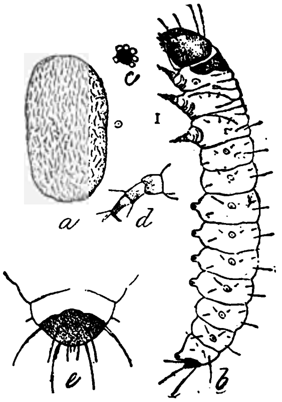

Fig. 9.

Peach-twig Borer: *a*, egg; *b*, young larva from side; *c*, eye; *d*, thoracic leg; *e*, anal segment above; all greatly enlarged. Marlatt, Bull. 10, n. ser., Div. Ent., U. S. Dept. Ag.

Yet this is a pest to be watched, as it may become destructive at any time. It is an imported species, and its habits are well known. The characteristic injury is caused by its eating into the young shoots of peach soon after they make a start, and killing these tips. The same larva may take several tips in succession, so that a comparatively few specimens can do a disproportionate amount of mischief.

Tent caterpillars and web-worms were not especially troublesome, though they were somewhat numerous in the northern part of the State; but we escaped entirely the destructive invasion by the forest tent caterpillar, which troubled some portions of New York and some of the New England States.

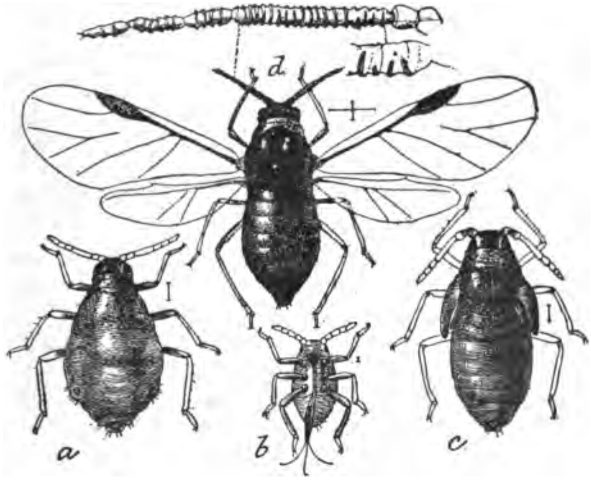

Fig. 11.

Woolly Apple Louse, *Schizoneura lanigera:* *a*, agamic female; *b*, larva; *c*, pupa; *d*, winged female, with antenna above; all much enlarged and with the waxy secretion removed. Marlatt, Circ. 20, 2d ser., Div. Ent., U. S. Dept. Ag.

The common orchard scales attracted more attention than usual, not because they were actually more abundant, but because the interest excited by the pernicious scale has induced fruit-growers to look after their trees much more closely than ever before. To answer the questions most generally asked as to the best methods of treatment, I prepared Bulletin No. 140, in which the result of all the experience heretofore gained in the treatment of these scales has been embodied.

The woolly apple louse is undoubtedly increasing in number, though hardly as yet doing serious injury. The characteristic patches of fluffy, bluish-white waxy material were seen altogether more frequently than ever before, especially on young trees. On some *Cratægus* plants they were very abundant indeed, and there is no doubt that nurseries are doing much just now to distribute this pest. This is one of the insects that can be reduced by fumigation with hydrocyanic acid gas ; a matter which is elsewhere referred to.

San José or Pernicious Scale.

This miserable creature has, directly or indirectly, absorbed a very large fraction of the time during the season, and, while the work done will be somewhat detailed on a later page, it may be said here that the insect is now to be found in every county in the State, that in some localities most of the orchards are infested, and that, in spite of this, new orchards are being set out constantly. I do not mean to say that the species is uniformly distributed throughout the State, but that in every county there are some localities, usually limited, though often not, that are infested.

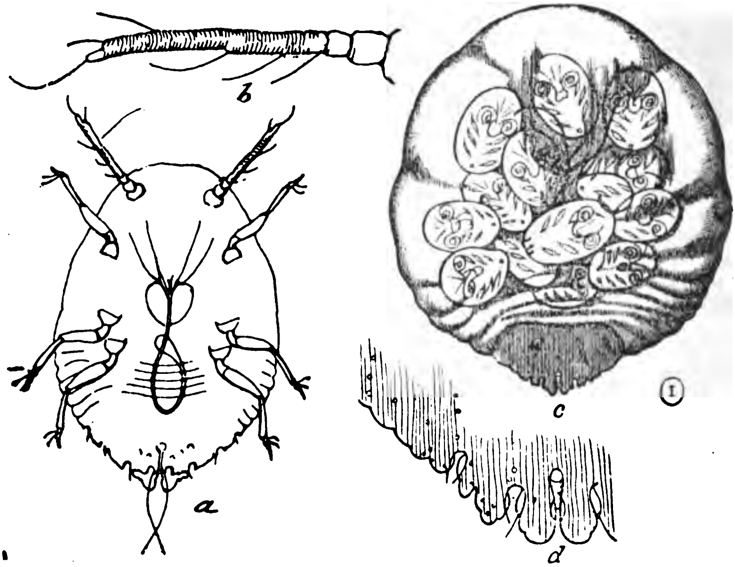

Fig. 12.

San José or Pernicious Scale : *a*, newly-hatched larva ; *b*. its antenna ; *c*, female with embryos showing through ; *d*, outline of anal plate of female ; all enlarged
From Howard, arc. 3, 2d sec., Div. Ent., U. S. Dept Ag.

This spread of the insect is not due to any natural distribution from known centers, but to the introduction of scaly stock from nurseries and to the discovery of localities in which the infestation is comparatively recent. It may be further added that more than 90 per cent. of the recent infestation has come from nurseries without the State, and almost all of this has come in under certificates. There is no doubt that the larger growers are generally anxious to have their stock absolutely safe; but there are many dealers who obtain certificates and make them cover a great mass of stuff that the inspector never saw. There is a further tendency to shirk the certificate requirement and to substitute therefor a declaration by the nurseryman. In the rush of business these "fake" certificates pass muster at the railroad stations, and, in the absence of any police power, the stock comes into the purchaser's hands. The purchaser may or may not read the printed matter on the tag, and usually accepts the parcel and the stock at its face value. I have had correspondence with several firms during the past season concerning infested stock received by New Jersey growers under certificate, and in every instance it was stated that it was stock they themselves had bought. These facts are discouraging, to say the least, and if similar stock goes into other States the attempt to prevent distribution is vain.

I am now advising all our nurserymen and dealers to put in fumigating-houses or boxes, so as to reduce the danger from purchased stock to a minimum. On this matter of fumigation a few words are said in another part of this report.

The matter of nursery inspection belongs rather to the report of the State Entomologist; but it is in place to say that, as a whole, our nurseries are in good condition. On several of them I found scale in left-over stock purchased last winter or spring, and heeled in around the packing sheds; but the infestation was usually slight, and prompt destruction of the stock followed discovery in every case. In every instance the stock had been received under certificate! I have advised our nurserymen to destroy all stock unsold each spring unless it could be set out at some point remote from the nursery at large and where there was no chance of infesting other trees.

Experiment Orchard.

Work and observation in this orchard has been continued and is proving decidedly useful. I have been enabled to test the crude petroleum as to its action on young trees much more fully than I would have dared to do on trees belonging to anyone else. The apple plant louse has been under continuous observation and many other species of minor importance were noted. It also gives an opportunity for the prompt trial of the effect of insecticides upon such insects as are found upon the trees. The variety of trees represented has been enlarged by a prune, an apricot and a nectarine. The record of the orchard forms a considerable portion of this report, and as the history is continuous will show just how much a tree will stand. Incidentally it will be developed that even in the matter of the pernicious scale individual trees differ in the amount of susceptibility.

SMALL FRUITS.

During the early part of the summer some time was devoted to completing the work previously begun on the strawberry leaf roller, and while there are yet some gaps in the life history, sufficient is now known to make definite recommendations possible. A bulletin will be prepared during the current winter, detailing the work done and the remedial measures to be adopted.

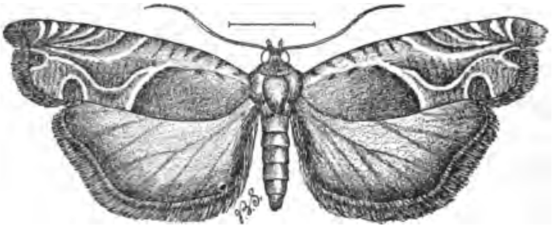

Fig. 13.

Parent of the strawberry leaf roller, *Phoxopteris comptana;* much enlarged.

The rose-chafer or "rosebug" was again locally destructive, and we have not yet found anything better than jarring or hand-gathering to deal with them. The immense numbers in which they appear suddenly, their ravenous appetite and their omnivorous tastes, all place their practical control by such insecticides as we now know, out of the question. Thus far there is no real threat of such an invasion as characterized the seasons of 1889–90 and '91.

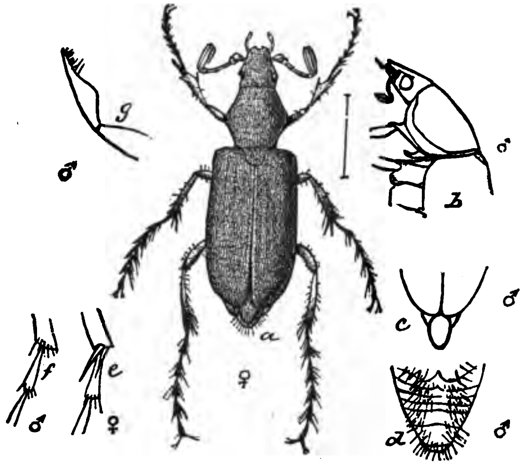

Fig. 14.

The rose-chafer, *Macrodactylus subspinosus*, with details of its structure; much enlarged. From Insect Life, Div. Ent., U. S. Dept. Ag.

Raspberries have in some localities been somewhat infested by scale insects, the scurfy and rose-scale in order, being the culprits, but no real injury has been done in any case.

The currants were not so fortunate; these have been troubled everywhere with either borers, slugs or pernicious scale, and sometimes by all three. Scaly currants have been quite generally distributed in a few sections, and I always advise that these plants be taken out, because they are easily replaced at smaller cost than would be required to treat.

As a whole small fruits escaped very well indeed during the past season.

Field Crops.

The Hessian fly has again injured wheat seriously in many localities, but there has not been as much complaint as in 1898. Late sowing was quite generally practiced and this has been usually effective. Some late-sown fields were somewhat or even considerably

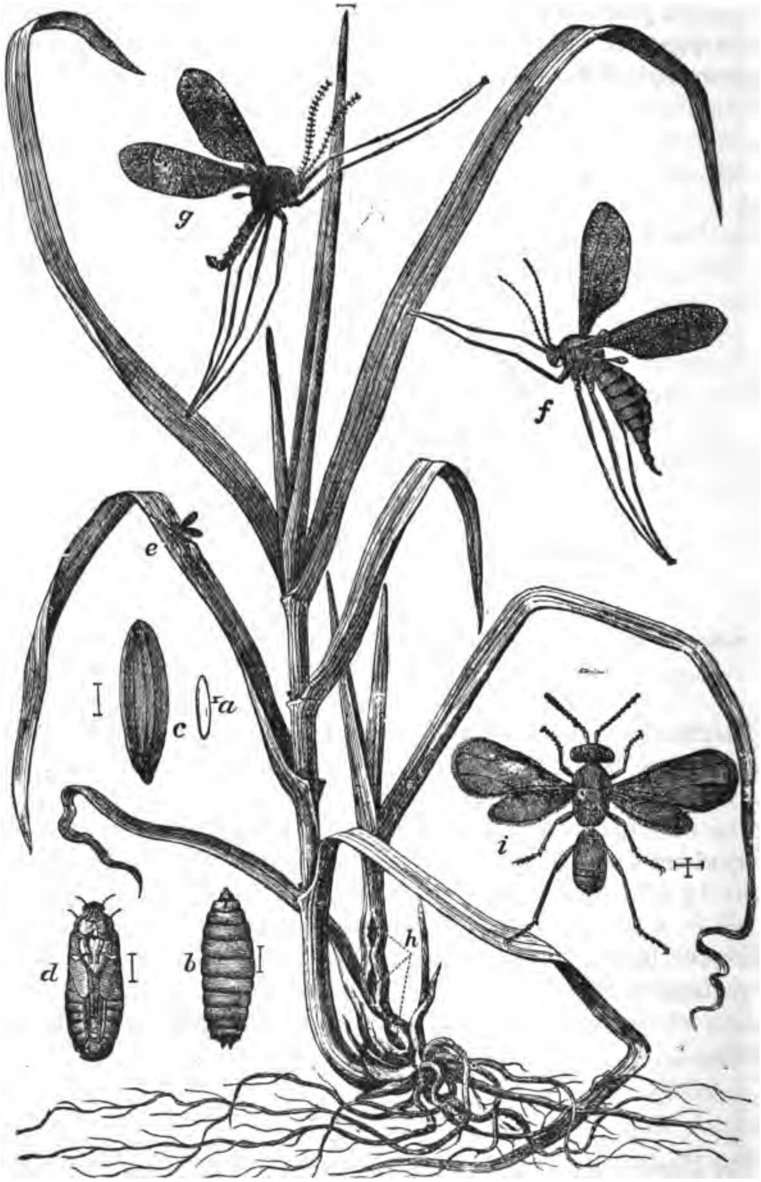

Fig. 15.

The Hessian fly. *Cecidomyia destructor*. On the left a healthy stalk of wheat and on the right one infested at *h*, by the Hessian fly, showing the galls; *a*, eggs; *b*, larva; *c*, "flax-seed" stage; *d*, pupa, all very much enlarged; *e* fly ovipositing, natural size; *f*, female; *g*, male fly, enlarged; *i*, the parasite *Merisus destructor*, much enlarged. From Div. Ent., U. S. Dept. Ag.

injured, but on the whole they were much more free than those sown early. It may be advisable, perhaps, if the insect is again abundant next year, to resort to a trap crop sown in late August, about one-quarter of a regular stand or even less, and turn this under when the regular crop is to be put in. In Burlington county some fields were not sown this year until after October 10th, and perhaps the more general freedom of the southern counties is due to the fact that sowing is much later, as a rule, than it is in the northern districts.

The grain-moth was much less complained of than last season, and a considerable percentage of the wheat in southern counties was threshed out of the field. A few cases occurred where the moths were afterward seen in the granary, and treatments with bi-sulphide of carbon were given with good effect.

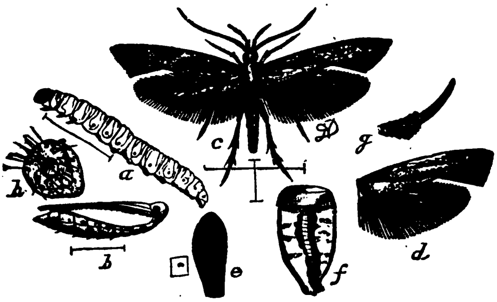

Fig. 16.

Angoumois Grain-moth, *Sitotroga cereallela*: *a*, larva; *b* pupa; *c*, moth; *d*, wings of a variety *e*, egg; *g*, *h*, structural details, all very much enlarged; *f*, larva feeding in kernel of corn. After Riley.

Corn was injured by a variety of pests, the most troublesome of which were the wire-worms, for which we have not yet discovered a satisfactory method of treatment. More complaints than usual came from the southern counties, while only a few instances of marked injury came to my notice in the northern counties.

The stalk borer, the larva of *Hydrœcia nitela*, was locally injurious in Hunterdon county, and this is the first time that this insect has been brought to my attention as doing real harm. Nothing can be done in a case like this except to cut the infested stalks and feed them. The presence of the larva will not impair their usefulness for that purpose. It is probable that this is only an accidental increase, and that another season will drop the insect back into its accustomed obscurity.

Corn-root web-worms yet continue to be heard from, but the practice of fall-plowing sod is extending, and less trouble is reported than in years past, where replanting was so much the rule that it was considered inevitable.

There was a local outbreak of army-worms in Sussex county in midsummer, and a small acreage of grain was destroyed; but nothing was seen of them later on, so far as I can learn.

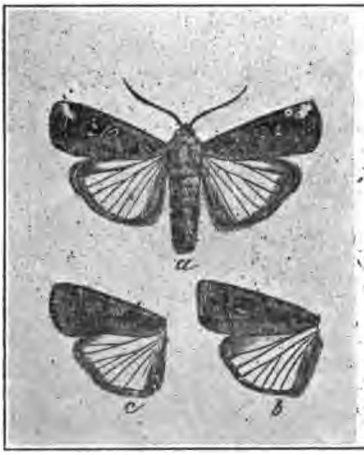

Fig. 18.

Moth produced by the fall army-worm, *Laphygma frugiperda*, and varieties at *b* and *c*, natural size. After Riley.

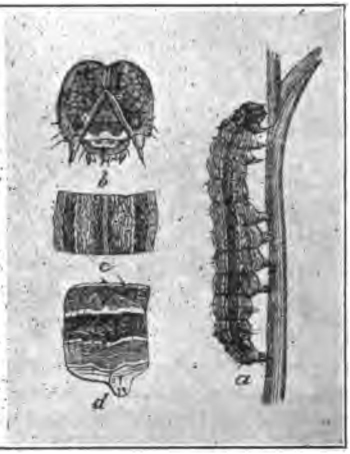

Fig. 17.

The Fall Army-worm: natural size at *a*; *b*, *c*, *d*, head and body segments, enlarged. After Riley.

In October, local outbreaks of the fall army-worm were reported from Gloucester and Camden counties, and, in November, from Middlesex county. This is interesting, not only because it is the first time that the insect has done harm in our State, but because in several of the Western States a very closely allied species has caused serious injury to sugar beets. It is not probable that this injury will increase; but should the species become locally troublesome, the arsenites sprayed on the food plant will serve as a direct killing agent, while the bran and Paris green method may also be used by running the dry mixture in rows ten feet apart across the infested field.

"Corn-worms," *i. e.*, those feeding in the ear, have been as abundant as usual, and from some observations made this year it seems likely that the insect does more injury than is usually noticed. In cutting some stalks of corn examined for other purposes, I found these larvæ devouring the embryo ear, before it had even become visible in any way above the leaf. Their injuries on tomatoes were quite as marked as usual.

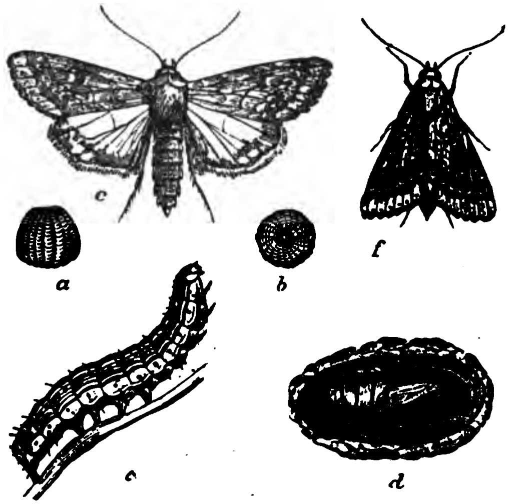

Fig. 19.

The Corn-worm, *Heliothis armiger*, in all stages: *a, b*, egg, enlarged; *c*, larva; *d*, pupa in its underground cell; *e, f*, moth's wings spread and at rest. From Div. Ent., U. S. Dept. Ag.

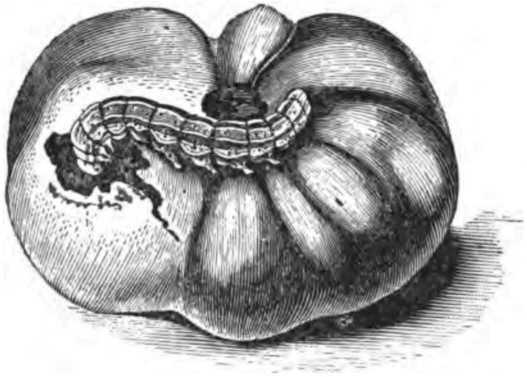

Fig. 20.

The Corn-worm feeding on a tomato. From Div Ent., U. S. Dept. Ag.

The Corn-feeding Syrphus Fly.

August 24th, Mr. G. Guenther, of Cologne, Atlantic county, sent me some sections of evergreen sweet corn containing a large number of maggots between the leaves and the stalk, nothing like it having been previously observed by him. There was about three-fourths of an acre of late sweet corn planted on strawberry land, which was just setting but beginning to look yellow. It was found, a few days previous, to be generally infested by these maggots and was being cut for fodder. Some late corn 200 feet away had the ears well set and there was some trace of the insects on the outside rows, but not enough to hurt any. On September 10th the sweet corn was all down and had been seeded with crimson clover; a few infested stalks were yet found on the neighboring field, but no apparent injury was caused.

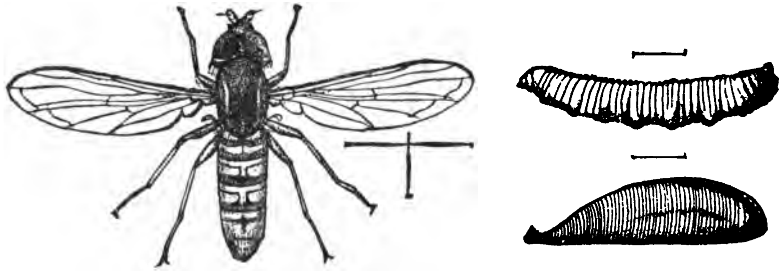

Fig. 21.

The Corn-feeding *Syrphus* fly, *Mesogramma politum:* larva, pupa and adult; all enlarged. From "Insect Life," U. S. Dept Ag.

When the specimens were received all stages were present, from the minute creature just out of the egg to the pupa, and in a very few days adults began emerging which were identified for me by Mr. C. W. Johnson as *Mesogramma politum* Say. I was then able to refer to an account of an exactly similar attack described by Dr. C. V. Riley in "Insect Life," vol. I., page 5, in July, 1888. This attack was at Griggstown, Somerset county, New Jersey, was noticed during the third week in August, 1885, and these larvæ were observed to feed upon corn pollen. It is certain that those bred in my laboratory had no corn pollen, and seemed rather to live upon the sweetish moisture that exuded from the surface of the stalk where it was completely enveloped by the leaf sheath. This accords also with Mr. Ashmead's observations in Florida, recorded by Dr. Riley.

It is curious that there should have been two such similar attacks so many years apart in such dissimilar localities in our State. The matter is interesting, but probably not of much importance, from the rarity of its occurrence and the fact that no real injury was observed in either case.

Truck Crops.

The chief pest on these crops has been a cut-worm, and sweet potatoes have suffered more than any other, as high as 25 per cent. of the entire plantings having been destroyed in some localities. Many farmers yet prefer taking the risk of serious injury by these pests to providing themselves with the material for the prompt use of the bran and Paris-green method, which has proved entirely successful wherever it has been employed.

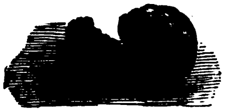

Fig. 22.

A cut-worm in characteristic position. After Riley.

Cabbages escaped very much more easily this season than in 1898, and the damage that occurred was due to the ordinary white cabbage butterfly or its larva, and not to the looper, which was, indeed, rather rare. This result was expected because abnormal multiplication of an insect that is always more or less common, is almost always brought under natural control within rather a brief period. It is notable further, in this connection, that the most successful remedy used was the bran and Paris green thoroughly mixed and sprinkled dry on the heads. The larvæ seemed to prefer this to the cabbage, to their prompt undoing.

Potato Pests.

There has been the usual fluctuation in the number of the potato beetles, some localities reporting more than ever before, others less; perhaps, on the whole, there were fewer than in 1898, though it is difficult to say exactly what caused the difference. A notable fact connected with this insect is that it is not at all unusual to receive nowadays specimens of the *Lebia grandis*, a blue and orange flattened beetle, not quite half an inch in length, which is found feeding upon the eggs. The habits of this Carabid beetle are such that it might easily maintain itself in tilled fields, hence it is not beyond the possibilities that it may in time graduate into an effective check for this common species.

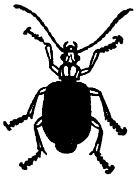

Fig. 23.

Lebia grandis. After Riley.

Incidentally it has been suggested more than half seriously that this potato beetle is becoming used to Paris green as a diet; because it now requires much stronger mixtures to kill it than it did in times past. I am not inclined to say positively that this is really so; but I have seen rather strong evidence in support of the view that some adaptation in this direction is really taking place.

Quite a new insect appeared as a potato pest at Blairstown in June, specimens of the very handsome blue and green *Eumolpus auratus* having been sent in with the information that Paris green would not kill them. The normal food-plant of this insect is the dog-bane (*Apocynum*), and its occurrence on potato seems to be purely accidental.

The striped blister beetles and the plant lice, which locally caused or threatened injury, are referred to elsewhere.

Blister Beetles.

Beginning about the middle of July, there came a procession of blister beetles of four species, which in the order of their abundance were *Epicauta vittata*, the striped blister beetle; *Epicauta cinerea*, the margined blister beetle; *Macrobasis unicolor*, the ash-gray blister beetle, and *Epicauta pennsylvanica*, the black blister beetle.

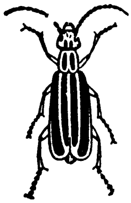

Fig. 24.

The striped blister beetle. After Riley.

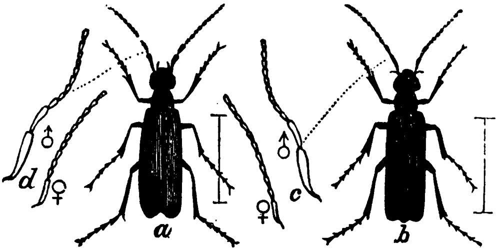

Fig. 25.

a, ash-gray blister beetle; *b*, black blister beetle; *c*, *d*, antennæ; all enlarged. After Riley.

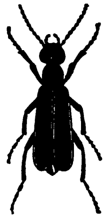

Fig. 26.

The margined blister beetle. After Riley.

They came from all sections, ranging from Hunterdon to Cumberland county, and attacking a wide range of plants; but the method of their attack was always the same: they appeared very suddenly, fed very ravenously, seemed quite indifferent to Paris green and disappeared as suddenly as they came, sometimes leaving serious wreck only behind them.

One correspondent writes: "I can safely say that with me it is one of the most destructive insects that ever preyed upon a garden. This is the third year in which I have observed them; tomatoes, beans, beets and several varieties of flowers are devoured with amazing rapidity."

Several persons noticed the fact that the insects preferred feeding on the inner, lower leaves of the potato and tomato vines on which they were most frequently observed.

During September they were reported on asters and chrysanthemums, and on these they ate the flowers; but left the other parts of the plants untouched.

A general account of these blister beetles is given in my report for 1893, and from this it appears that in the larval stages the insects are beneficial rather than otherwise. The fact that they appear in such swarms and so suddenly makes it difficult to deal with them. They resist arsenites quite strongly, and before it takes effect the mischief is done. They do not like lime, however, and the Bordeaux mixture thoroughly applied serves as a repellant. On flowers, collecting in pans containing a little kerosene, is the most effective method, and this is preferably done quite early in the morning, while the insects are yet sluggish, or late in the afternoon, when they are becoming so. They should be somewhat carefully handled, since their juices possess blistering properties, especially on the softer skin surfaces of face and neck.

Shade Tree Insects.

More inquiries than ever received on this subject, often from town officials, indicates a continued growth of interest. It does not follow by any means that the question is followed by action upon the advice given; but even that has occurred in a few cases.

As to the species complained of, these have been about the same as usual; the elm-leaf beetle leading, on the whole, though the "wood leopard moth" has caused the most actual injury.

Bag-worms have attracted much more attention than usual in all sections, quite a number of cedar trees and *Arbor vitæ* hedges being reported as completely destroyed. The species has not been especially troublesome on orchard or deciduous trees generally, and its damage to conifers comes largely from the fact that these plants do not stand complete defoliation. It always requires two or three years for the insects to become very numerous at any one point, because the original infestation must come from a wandering caterpillar that produces a female. The adults of this sex have no wings, hence there can be no infestation in the early season unless a bag with eggs has wintered on the plants. It must be the object of every owner of an evergreen hedge to watch it carefully, and every winter to make or have made a careful examination of every part of it, removing and burning every bag that is found. In the early stages the insects succumb quite readily to the arsenites, but when they become more than half grown they resist strongly, and very concentrated mixtures must be used. On evergreens the arsenate of lead is the safest, and it is really the only thing that can be employed against the nearly full-grown larva. It should be at the rate of 15 ounces in 40 gallons of water to be at all prompt in effect. If Paris green is used, lime must be added to equal it in weight, and 1 pound in 100 gallons will be required. At this strength there is danger of "burning," hence care must be used in making the application.

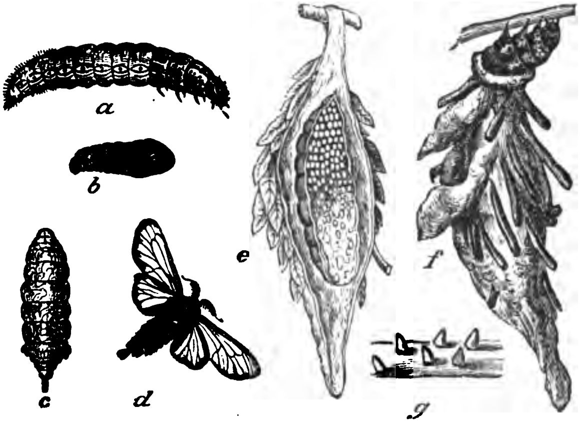

Fig. 27.

The Bag-worm in all stages: *a*, larva; *b*, male pupa; *c*, female adult; *d*, male adult; *e*, bag cut open to show the egg mass; *f*, caterpillar carrying sac in normal position; *g*, young larvæ with bags carried upright. After Riley.

The maple has been unusually subject to attack during 1899, the cottony scale, *Pulvinaria innumerabilis*, having been locally injurious on many city trees. The woolly louse, *Pemphigus acerifolia*, was reported from New Monmouth in June as very abundant, covering everything around the tree with a whitish fluid.

The false-scale, *Pseudococcus aceris*, is again on the increase in the places where it was plentiful three or four years ago, and was reported from several localities where it had not been heretofore noticed. At New Brunswick the insect was found in all parts of the city, noticeable enough on trunks and leaves, but not in such enormous abundance as it was in 1895, when it made its first appearance with us.

The tulip soft scale, *Lecanium tulipifera*, has formed one of the subjects of special study during the season and a bulletin is in course of preparation. For several years past this insect had become increasingly abundant at Vineland and some other points in South Jersey, and the trees were showing the ill effects quite markedly. In 1899, while I found the over-wintered larvæ quite plentiful and in good condition in early spring, they died off very soon afterward, leaving the trees more free from the pests than they had been for years past. This was not due to either parasites or predatory forms, though both were present; it was a dying off without obvious reason when the stage at which the insects became sexually mature was reached. Other points were not so much favored, and there was no difficulty in securing material sufficient to complete my studies on the insects.

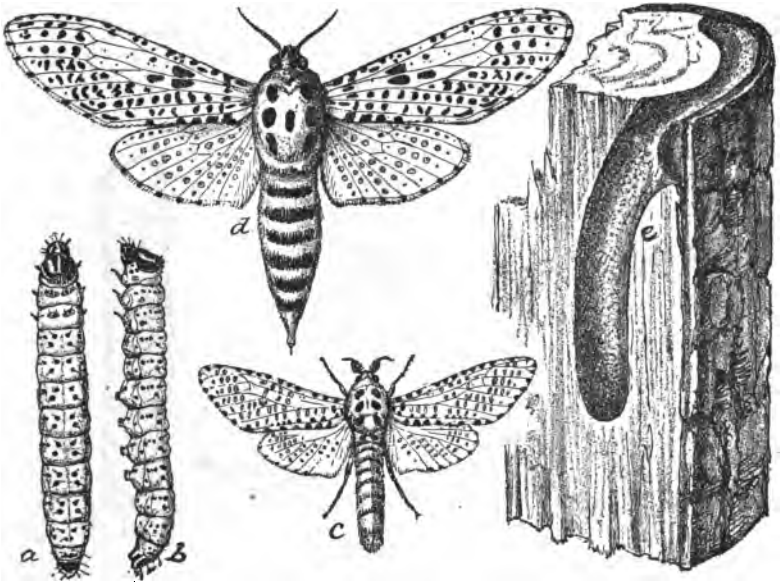

Fig. 28.

The Wood Leopard Moth: *a*, *b*, half-grown larva from above and side; *c*, male; *d*, female moth; *e*, larval burrow showing the tendency of the larva to girdle its food-plant. From Div. Ent, U. S. Dept. Ag.

Late in October there was brought into the laboratory a branch of elm that had fallen from one of the city shade trees, and this proved to have been completely girdled by the wood leopard moth. This is the first appearance of this insect in New Brunswick, so far as my observation extends, and I have been on the lookout for it continuously. It was, perhaps, inevitable that the insect should gradually extend its range, and New Brunswick is on the direct line of railroad from Elizabeth, where the insect has been known to occur for several years. Just how troublesome it will be in this city it is impossible to say; but as the sparrows have not excluded quite all our native species there is some hope that it may not be serious.

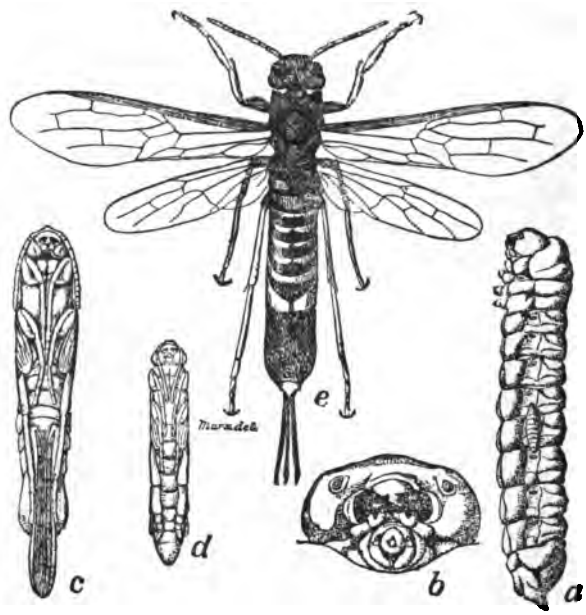

Fig. 29.

The Pigeon Tremex: *a*, larva; *b*, its head, enlarged; *c*, *d*, male and female pupa; *e*, female adult. From Div. Ent., U. S. Dept. Ag.

Another insect that does more mischief than is generally charged to it is the pigeon Tremex, which infests elm and other trees in considerable numbers, oftentimes weakening the heart-wood so as to cause the breaking of branches in a high wind.

INSECTICIDES.

The subject of insecticides has received unusual attention of late years from makers and dealers and a number of new and probably meritorious articles have been put upon the market.

Arsenate of lead is now obtainable in paste form from Wm. H. Swift & Co., 66 Pearl street, Boston, Mass., and that this is effective and a good material we have the testimony of Mr. A. H. Kirkland, of the Gypsy Moth Committee in Massachusetts, where this arsenate of lead originated.

The Adler Color and Chemical Company, 100 William street, New York City, have been experimenting for and with the Division of Entomology in the United States Department of Agriculture, and have produced a "green arsenoid," which is an arsenite of copper, a "pink arsenoid," which is an *arsenite* of lead, and a "white arsenoid," which is an arsenite of barium. They have also a dry form of the *arsenate* of lead which is not satisfactory because it precipitates too rapidly, being even worse than Paris green in this respect.

The most promising of these is the green arsenoid, which contains about 62 per cent. arsenious acid, and costs 12 cents per pound. It has been thoroughly tested and is highly recommended by Mr. Marlatt, of the Entomological Division of the United States Department of Agriculture, and Mr. M. V. Slingerland, of the Cornell Station. It is very much finer in grain than Paris green, remains in suspension much better, is quicker in effect and said to be entirely harmless to foliage at all reasonable proportions.

Mr. James Good, of Philadelphia, who prepared the potash soap No. 3 for use against the pernicious scale at the suggestion of the Entomologist of the United States Department of Agriculture, has now added to this soap a tobacco extract to increase its effectiveness, at the suggestion of Mr. Alwood, of the Virginia Station. This should be an improvement, theoretically, and especially where the soap is to be used in considerable dilution on plant lice or against young scale insects. It costs a little more than the potash soap, and the range of usefulness with this addition remains to be determined.

As to kerosene, there is almost hopeless confusion in the testimony. It is questionable, perhaps, whether it is worth while to go into much detail, because we have now at command a better material for winter work, and can reduce the oil without practical loss of effect for summer applications. Yet two or three striking cases may be noted.

June 9th, on the Allen nursery, near New Brunswick, two nursery rows of peaches were sprayed with undiluted kerosene in the middle afternoon. The trees were infested with a Thrips, and the experiment was made in part to note the effect on this insect. Application was made from Vermorel nozzles from both sides of the rows, and a thorough dose was given. I fully expected serious injury on this young peach foliage, but was surprised when, ten days later, I found no material harm done. (See Figure 2, *2*, *ante* page 427.) In the entire section not half a dozen twigs were killed and not a single plant was materially injured by the spray. To make certain of my case, I wrote for information early in September, and received on the 4th of that month advice as follows: "The row of peach trees you refer to was not seriously injured, although the leading branches of several trees were killed. We think, however, that this amounts to nothing, from the fact that the machine had been used last with Paragreen and had not been properly cleaned. Paragreen will kill the leaves, young shoots and even large branches of peach trees. We used pure kerosene from the middle of May to the 10th of June on pear trees, applying it with a brush on the bodies and the entire tops, including the present year's growth and even the young leaves, with not the slightest injury to the trees.

"We also used the kerosene as above on apple, European and Japan plum, in the first part of June, with no apparent injury to the trees!"

May 15th, I spent a day in Atlantic county, near Cologne, and found several hundred trees that had been treated during the past winter, all of them in good condition. In one case pear trees in good condition had been treated to pure kerosene with a whitewash brush, in March, two years in succession. Apple, pear, peach and plum have been safely treated in this district, in considerable numbers.

I might multiply instances of this kind; but on the other hand will note one case in Cumberland county, where all the trees treated with kerosene in September were killed; no details as to number of varieties were given.

Another case, reported to me verbally, was in Camden county, where Duchess pears were sprayed, not because they needed it, but "on general principles," and on these the fruit buds were seriously injured though the trees themselves were not much harmed.

There have been other cases of injury reported, and enough has developed to show definitely that while we have an exceedingly efficient tool in kerosene, whose use I do not hesitate to advise when there is need, it is also one that must be intelligently employed to avoid danger.

It was with this thought in mind that I carried on the experiments with crude petroleum which are detailed in Bulletin No. 138, and in this material we have, I believe, an insecticide which can be used with a reasonable degree of safety to the tree and with killing effect upon the insects.

Crude petroleum as an insecticide was referred to in my last report, and experiments were continued during the winter of 1898–99 and the summer of 1899, so that its range and effect in our own State may be said to be fairly well understood. The details given in Bulletin No. 138 will not be repeated here, but in the records of the experiment orchard and in what is said concerning the pernicious scale much will be found concerning crude oil. This oil is not cheaper than the refined kerosene, since the main items in cost are made up of transportation and barrel charges, which are exactly the same for both products, and crude oil has no large or very general sale. Its main advantage over kerosene is that it is practically harmless to dormant trees, even when employed in liberal quantities. It contains, beside the light or volatile oils which disappear rapidly, a heavy residue which forms a greasy or oily coating on the bark, lasting for months and apparently fatal to all scales that set on it. The oil has not been in use long enough to enable us to say with certainty just what its range is, but individual trees have been under observation for two years without showing any appearance of harm.

Whale-oil soap has held its own for winter applications on peach trees, 5,770 pounds of Good's Potash Soap No. 3 having been sent into the State between November 1st, 1898, and May 20th, 1899; March and April each having about 1,800 pounds credited. Most of this was used in Burlington county, and it gives an indication of the work that it is doing to check the spread of injury from the pernicious scale. At several of the worst-infested orchards the growers made their own soap, and this, with the Leggett and other soaps, concerning which I had no absolute figures, will bring the total amount very close to 10,000 pounds, at an outlay for material, transportation and other expenses of not less than $500, aside from the cost of application.

Miscellaneous.

In the course of the summer a great many letters are received asking information about insects that are locally troublesome, *i. e.*, white grubs in violet houses, May beetles in chestnuts, household insects and the like. To reply to all these takes time, and the correspondence of the office is evidenced by 1,370 pages of letter-book for the calendar year, representing at least 1,500 separate communications.

Lectures or addresses have been given in almost every county in the State during the year and before the State Board of Agriculture and Horticultural Society.

Bulletin No. 138, on crude oil as an insecticide, was published during the year, and a bulletin on three common orchard scales is now ready for publication. A bulletin detailing the life cycle and remedial measures to be adopted against the apple louse, another on the tulip soft scale, and a third on the strawberry leaf roller are in course of preparation.

The list of the insects found in New Jersey has been completed and is ready for the printer.

Early in February a few days were spent among the collections at Washington, D. C., and much information was obtained through the courtesy of Dr. L. O. Howard and his assistants at the Department of Agriculture and at the United States National Museum. Twenty-three days were spent in whole or in part in actual field investigations aside from the forty-nine days spent in whole or in part in the work connected with the San José inspection trips. About fifteen days were employed in nursery examinations, and a few odd trips to New York, Newark, Trenton or Philadelphia make up a very busy summer.

As in the past, I have maintained my connection with the Entomological Societies at Brooklyn, Newark and Philadelphia, and owe much to the very cordial co-operation of their members in all matters concerning which they were able to give me information.

The collections of the Department have increased greatly, and an effort will be made to get them into more systematic order during the winter now at hand.

Aside from the work done for the Stations and as State Entomologist, a short report on the "Role of Insects in the Forest" was prepared for the State Geologist.

ENTOMOLOGY IN THE CROP BULLETIN.

The first pests to be reported by the crop correspondents were cutworms, from Kingwood, Hunterdon county, where they were troublesome, May 9th. At Mantua, Gloucester county, they were "very destructive" on sweet potatoes, May 16th. They were complained of at Frenchtown, Hunterdon county, May 23d, and on the same date appeared at Trenton Junction, Mercer county, and were very numerous at Hammonton, Atlantic county, May 30th; some complaint was made at Readington, Hunterdon county; they did much damage to corn at Rocktown, were very troublesome at Sergeantsville, both in Hunterdon county; numerous at South Bound Brook, Somerset county, and very destructive at Staffordville, Ocean county. June 6th, they were noticed at Peapack, Somerset county. June 13th, they were doing some damage at Beverly, Burlington county. June 27th, they damaged late corn at Farmingdale, Monmouth county, and thereafter did no further reported mischief.

Currant worms were mentioned once only, from Kingwood, Hunterdon county, May 10th.

Potato beetles were first reported from Mullica township, Gloucester county, and Salem, Salem county, May 10th, and not until June 6th were they again noted, this time from Hightstown, Mercer county, and Readington, Hunterdon county, where they were abundant; while at Kingwood, also in Hunterdon county, they were "not as numerous as in former years." June 13th, they occurred "numerously" at Merchantville, Camden county. June 27th, they were "numerous" at Oradell, Bergen county, and the same report came, July 11th, from Rowland's Mills, Hunterdon county. July 25th, they were getting troublesome at Kingwood, Hunterdon county. August 29th, it was stated that at Millington, Morris county, they had destroyed the vines, and had become "very numerous" at South Bound Brook, Somerset county. At Franklin Park "millions of potato bugs fill the wagon ruts in places, covering almost everything between Deans and Jamesburg; some gardens are completely devastated by them; they are cleaning up everything in the shape of vegetables"—and this ends the record.

Some fly in wheat was reported from Pennington, Mercer county, May 23d. A week later it was found doing "much damage" at Rocktown, Hunterdon county; "some damage" at South Bound Brook, Somerset county, while at Titusville, Mercer county, the wheat was "full of Hessian fly." June 20th, the wheat was falling badly at Titusville on account of this fly. June 27th, wheat was "down and in bad shape for cutting" at Plainfield, Union county, while in harvesting it "was found to be seriously injured" at South Bound Brook, Somerset county. July 4th, complaint was made from Belvidere, Warren county; wheat was found to be "somewhat injured at harvest" near Freehold, Monmouth county; was "much damaged" at Somerville, Somerset county, and "a light crop," owing partly to the Hessian fly, at Titusville, Mercer county. At this place the farmers had done no seeding September 12th, because of the fly, and at Trenton, also in Mercer county, seed wheat was "very scarce, the grain being destroyed by the fly."

Wire-worms were said to be damaging corn and truck at Sergeantsville, Hunterdon county, May 23d, and this is the only complaint of these pests.

Squash bugs became destructive at Fishing Creek, Cape May county, May 23d, and melon bugs were doing considerable damage to cantaloupes, May 30th, at Beesley's Point, Cape May county, and Mickleton, Gloucester county. June 6th, "melons attacked by bugs" is the report from Farmingdale, Monmouth county.

It is quite likely that at least the last record should be credited to the striped beetle, which injured melons and cantaloupes at South Dennis, Cape May county, June 13th.

The onion maggot was very destructive in Deerfield township, Cumberland county, May 30th, and this is the only report on this insect.

"Curculios" were "numerous" at Mickleton, Gloucester county, May 30th, and had done considerable damage at Woodbine, Cape May county, June 27th. At Cape May City, Cape May county, plums were reported a total failure, July 25th, because of curculio injury.

"Rosebugs" first made their appearance in numbers at Cape May Court House, Cape May county, June 13th. They had injured the grape crop at Cassville, Ocean county, June 20th, and were injuring grapes and apples in some sections near Ocean City, Atlantic county, July 4th.

Web-worms were noticed at Cape May Court House, Cape May county, June 20th. At Huntsburg, Hunterdon county, they made their appearance August 8th, in such numbers as to threaten serious injury to the apple crop.

Plant lice on cantaloupes were first reported, June 27th, from

Ocean View, Cape May county. On July 4th, they were getting troublesome on watermelons at Clayton, Gloucester county, and were appearing on citron vines at Moorestown, Burlington county. July 18th, some citron fields were infested with lice at Deerfield, Cumberland county, and no further complaints were afterward made until September 5th, when Mount Holly, Burlington county, reports all cantaloupe vines destroyed by lice. However, we find in the same bulletin that the markets were glutted with such fruits, hence the injury can hardly have been serious from a money point of view.

Cabbage worms were first reported as troublesome from Kingwood, Hunterdon county, July 4th, on which date they also made their appearance at Piscatawaytown, Middlesex county. August 8th, they were very numerous at the latter place, and thereafter no further reports came in.

"Peas poor; lice destroying crop," was reported from Farmingdale, Monmouth county, July 4th, and this is the only record of the most destructive insect invasion of the year.

"Early corn about half a crop and very wormy" came from Fishing Creek, Cape May county, July 4th, and seems to have been a case of local injury.

July 4th, it was noted from Moorestown, Burlington county, that the "wheat is nearly all stored or threshed, which is being pushed from fear of angoumois grain moth," and this fairly pictures the general practice during the present season throughout a large part of South Jersey.

At Hazlet, Monmouth county, the apple trees were full of small green lice July 11th.

Tomato worms, *i. e.*, those boring into the fruit, were reported July 11th from Fishing Creek, Cape May county, Marlton and Moorestown, Burlington county, and South Dennis, Cape May county, but later they were not again referred to.

Plant lice also were reported on tomatoes July 11th, from Marlton, Burlington county, and Mantua, Gloucester county, nothing more being heard of them thereafter.

Corn-root web-worms did some injury to the crop at Titusville, Mercer county, but seem not to have been noticed elsewhere.

July 25th, apples promised an 80 per cent. yield at Mount Holly, Burlington county, but were still dropping on account of insect stings. At Cape May City, Cape May county, on the same date, apples showed "the ravages of insects, and emphasized the need of spraying."

"Many pear trees have been killed during the past few years by borers" is the report from Hilton, Essex county, the sinuate pear borer being the one referred to.

At Woodbine, Cape May county, the spotted vine chafer was active in the graperies August 1st.

On August 22d, cranberries were esteemed a failure at Mullica township, Gloucester county, grasshoppers and crickets having been "very destructive."

Last of all, army worms appeared September 12th also at Mullica township, but the crows and robins were engaged in devouring them.

THE EXPERIMENT ORCHARD.

It is assumed that the report for the year 1898 is at hand for an explanation of the scope of this orchard and for the history of the trees set out upon it. It may be again said, however, that securing either fruit or good trees is a secondary consideration. The primary object in setting it out was to obtain material which could be used without restriction, whatever the probable effect of the experiment upon the tree. For the same general reason scaly trees were planted so far as they could be secured, and the record for 1898 shows that in November very few trees were entirely free from the San José scale. Some trees died for one reason or another, as will appear later, and these have been replaced by others.

There is yet plenty of pernicious scale on a few trees, but it never was the intention to clean out the scale, because this would have destroyed the usefulness of the plantation in one direction. The trees have been well treated so far as plant-food is concerned, and most of them have done fairly well. Some, indeed, have done all that could possibly be expected of them under circumstances much more favorable, and among these are subjects of some of my oil experiments.

A mixed, complete fertilizer, made up of Experiment Station samples, was applied in June and worked into the top soil. In July a good dressing of ground bone and muriate of potash was applied, left as a top dressing through a rain and afterward worked in.

The general record is that on June 11th I made a general search for scale larvæ, finding none.

June 17th, applied complete fertilizer as already stated.

June 18th, made a second examination for scale larvæ, and found a few on trees noted later. There had been no rain since April, and everything showed the effects of lack of moisture.

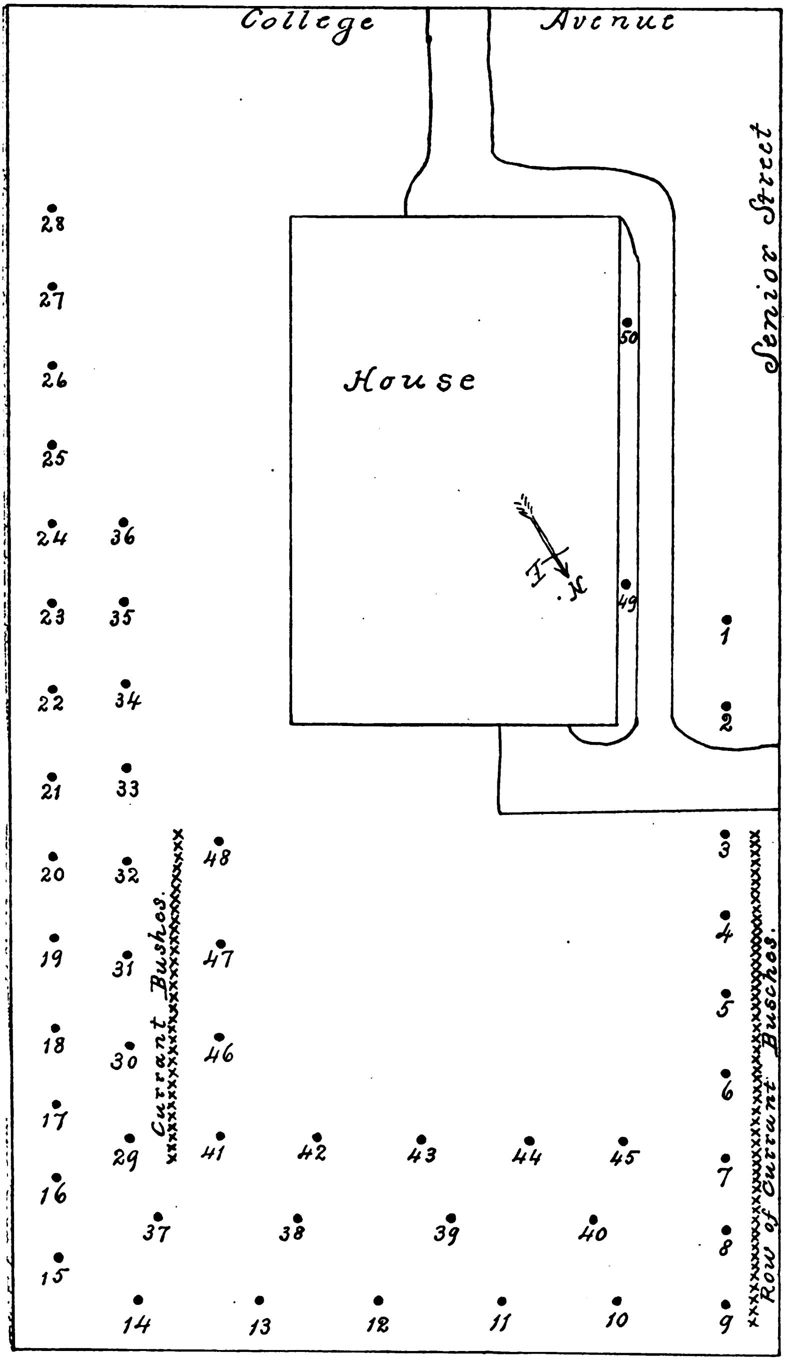

Fig. 30.

Plan of the experiment orchard. It is not accurate as to scale, but shows the relation of trees to each other. The short row of currants between trees 29 and 41, etc., has been taken out.

June 19th, used 15 per cent. kerosene, with Deming Vermorel nozzle and bucket emulsion pump, on trees 2, 6, 15, 32, 36 and 38. Day bright, sunshiny, wind light from southwest.

June 20th, an extremely heavy storm broke the long drought at 8 P. M., and tree 32 was blown down. Lightning excessive, struck the house and tore out part of chimney, rain a deluge for half an hour.

June 26th, rained more or less all day the 25th, and a heavy mist at night. This morning the tips of nearly all the peach trees are more or less scalded. Often the entire tip is killed and yellow, sometimes only the small leaves are affected, leaving the growing shoot intact. The trouble is uniform on all the vigorous trees. The runts show nothing of it.

July 8th and 9th, made another general examination for larvæ and found none; not a recent scale could be seen, and only comparatively few half-grown examples. On only one tree were the scales easy of discovery. On most of the peach trees examination was difficult because of their rank growth, and in most cases it was confined to the trunk and new growth. Almost all the pear trees had already stopped growth for some days as the result of the drought; but this is so in many commercial orchards as well.

July 23d to 26th was a period of cold fog and rain from the northeast, interspersed with intervals of watery sunshine or boiled winds from the south.

July 28th, 29th, all the trees had a mixture of ground bone and muriate of potash. Rained the night of 29th, 30th, but not heavily, and in the course of the next three or four days all the fertilizer was dug in.

August 14th, noticed crawling larvæ on tree 1, and on the 15th made a systematic examination of all trees. Now find isolated specimens on many trees, and on two, specimens that have entered the gray stage. The majority were white, and very few moving larvæ were noted.

August 27th, an examination was made chiefly to note the stoppage of growth and general character of the foliage.

September 18th, another examination as to stoppage of growth, the scale examination being incidental merely. When its presence is noted, it was obvious, and when not seen it is no proof that there were not some on the tree.

September 30th, October 1st, heavy frosts at night; killed Nasturtiums, Castor beans and other vegetation.

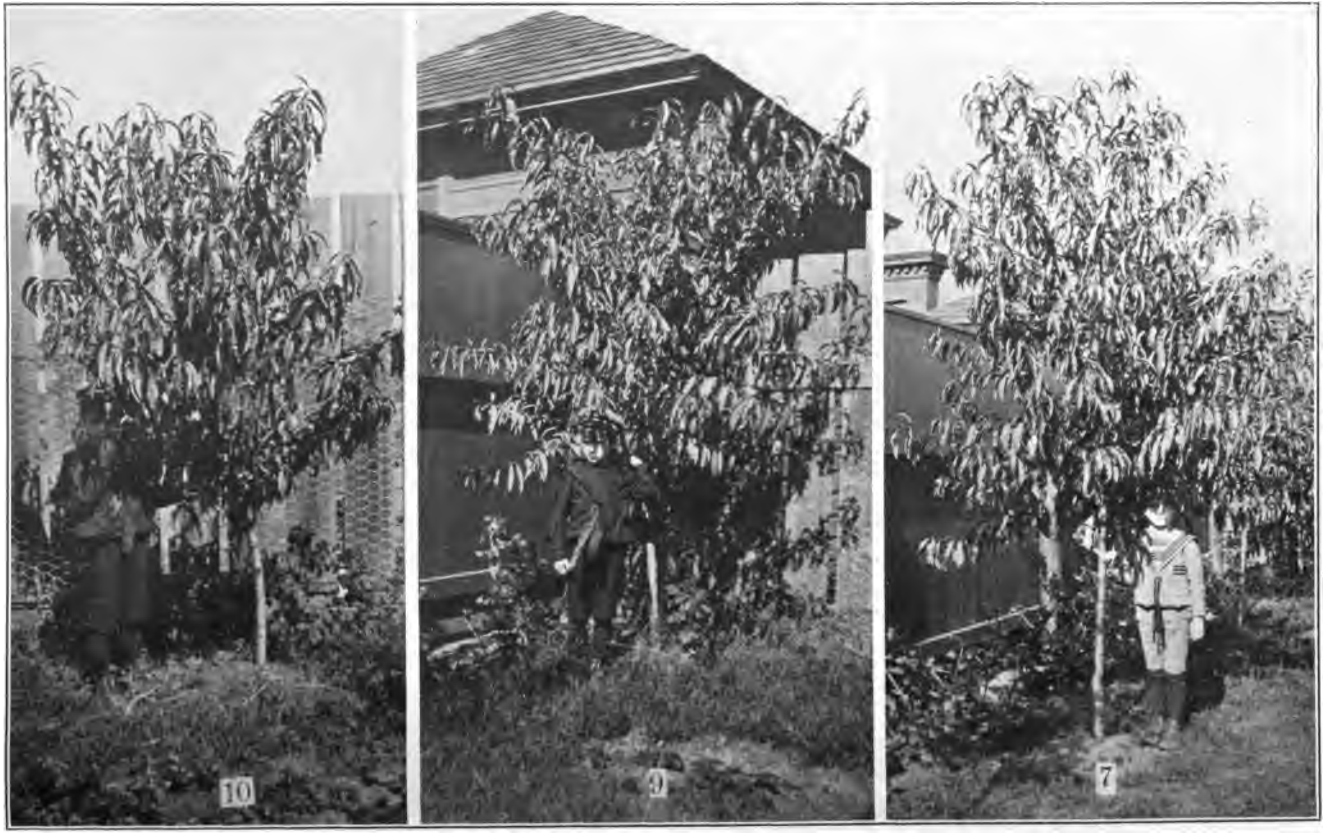

Fig. 31.

Experiment Trees: *7*, Sprayed with Crude Petroleum, Undiluted, February 20th, 1899. Painted with same February 28th; *9*, Sprayed with Crude Petroleum, Undiluted, May 15th, 1899; *10*, Drenched with 40% Crude Oil and Water in Mechanical Mixture, May 20th, 1899.
All from photos, made about October 5th, 1899.

October 15th, for a week past the nights have been very foggy, the days warm, with little or no wind. On the 7th, foliage in general began to tint rapidly; on the 10th it was a blaze of the most intense color, and the woods everywhere presented a glorious appearance; on the 11th it was already beyond its prime, and on the 12th it began dropping from elm and maple in great quantity. On the 14th, dead brown predominated and many trees were almost bare. In orchards many Keiffer pear trees became deeply tinted in bronze, yellow or deep red, and in the experiment orchard, one tree went in the same way. On such trees the foliage is dropping unusually early. A general examination as to condition and scale infestation was made this day.

October 22d, heavy frost last night; ice formed on a pool this morning.

October 23d, all the foliage was off or ready to drop from trees 2, 15, 16, 17, 18 and 35. On all the peach the leaves can be stripped from the shoots without effort, but they are not dropping of their own accord.

November 19th the final examination was made with the foliage completely off most and thin on the remaining trees, so that the trunk and branches could be more easily and thoroughly examined than at any previous time.

It may be added that the trees were kept under constant observation, and examinations of special trees were more frequently made. The dates above given simply indicate the times when all the trees were systematically inspected to determine some general condition.

The notes following begin where those of the last year left off:

Tree 1. Mariana Plum. Yet full of foliage November 20th, 1898, and did not become entirely bare until after December 10th.

In the spring of 1899 buds were forcing April 6th, and on May 11th it was in full leaf and growing well. It made a good bushy growth, and on June 18th a few crawling larvæ and some white scales were found. Decided to allow breeding to go on to see if the increase would be normal this year.

July 8th, while the tree was growing well not a crawling larva nor a recent scale was to be seen, and in fact it was not easy to find scale at all. The tree is branched very low down, and near the surface found a group of larvæ just setting August 14th; nothing seen further up the tree. On the 27th the shoots were four feet long and yet growing. They were still increasing in length September 18th, and no scales were obvious upon them.

October 15th found the scale again breeding, but close to the trunk only and not at all abundant. The foliage is yet complete, but mature and strips easily. The tree has made a very good growth, and while very bushy is stout and strong.

The tree has had no treatment of any kind since it was received in the spring of 1898. It was scaly then and it is scaly now, but the infestation is so slight that at the same rate of increase the tree will never need treatment of any kind.

Foliage was less than half off November 19th, and no change had taken place in the scale situation.

Tree 2. Yellow Transparent Apple. The tree was yet in full foliage November 20th, 1898, but lost it by December 1st. The buds began forcing April 15th, and on May 7th, 1899, it was in full leaf and growing well. At this time I examined about fifty scales, two of which proved to be alive, and I therefore left matters untouched for further development.

Crawling larvæ were first found June 18th, at which time there were no white scales yet. The tree was growing well, the foliage on one branch badly curled by plant lice, among which were a number of Coccinellids feeding.

June 19th, at 6:30 A. M., sprayed thoroughly with 15 per cent. kerosene with Deming emulsion pump and Vermorel nozzle. The tips and edges of a few leaves on the lower part of the tree were scorched. June 25th and on July 8th no scales in any stage on new growth and no recent scales on old growth were seen. Some injury had been caused by plant lice, however, and leaf hoppers in the immature stages were becoming numerous and spotting the leaves.

July 15th, noted one branch girdled by a bark blight and cut it off well below the point of injury. A few larvæ and recently-set scales were seen on the trunk on August 15th, but none were on the branches or on the new growth. August 27th growth had ceased, and the foliage was badly spotted by leaf hoppers. A number of half-grown scales were seen on the new wood September 18th, and on October 15th the tree was listed as only fair, foliage yellow and about ready to drop, some already off, some scales on the trunk, a little on the branches and hardly any on the new growth. There was quite some woolly louse, one colony of which I crushed.

October 23d, the foliage was practically all off. Plant lice were present in numbers and laying eggs, not only on the twigs, but on the trunk in scratches made by the cat, where also several colonies of woolly lice were established. Let everything go as it was.

This tree had only one application since it was received, and it was a scaly tree when set in the spring of 1898.

October 25th. Day dry, warm, hazy. Stripped off the remaining foliage, and at 4 P. M. painted thoroughly with crude petroleum. The application was especially directed to the buds, all of which were drenched.

Tree 3. Stump Peach. This tree was so unsatisfactory and peaches were so much in the majority in the experiment orchard that it was taken out November 20th and a *Black Tartarian Cherry,* free from scales, was put into its place.

April 15th, the buds were swollen, and May 7th, the tree was in full foliage. The tree had been well cut back, but one cluster of five blossoms developed and on May 27th two fruits were set. One of these was accidentally removed, the other ripened and was eaten before July 8th. On August 27th the shoots were well developed and had stopped growing. No scales were found October 15th, and the tree was yet in full foliage October 23d.

This tree since it was set made a normal growth, and has had no adverse conditions to contend with. It is in good shape to serve as a subject for experiment if necessary.

Foliage was yet complete, but brown, November 19th.

Tree 4. Abundance Plum. On November 29th, 1898, there were yet a few tufts of foliage at the tips of the new shoots, all of which disappeared before December 1st. In the spring of 1899 buds began to start April 15th, and on May 7th the tree was in full foliage, some of the shoots four to six inches long.

June 11th, the presence of a few scales was verified, but no larvæ or young scales were noted during the summer examinations. Not until October 15th did I find some young scale in the middle of the tree, which at that time was yet in full foliage; the latter just a little bronzed, but otherwise in good condition. This tree has grown well, and the only adverse circumstances developed September 18th, when it was discovered that the cat was using the trunk as a subject upon which to test her claws. The trunk was pretty well gashed and slivered before the culprit was located, and was then protected for a few weeks with a cloth wrapping. The gashes seem healing over.

As to the scales, they have just about held their own during the year. The tree became infested in the fall of 1898, and, though it has had no treatment of any kind, there are scarcely more now than there were a year ago.

November 5th, the foliage was practically all off, and on the 19th it was all gone. A few old scales were found, but nothing recent and nothing on the new shoots.

Tree 5. Stump Peach. This was my finest peach in 1898, but the occurrence of the fruit-bark beetles in the fall and an injury attributed to borers marked a weakened condition at that time, though it held its foliage until after November 20th.

April 15th, the main shoot was just starting, and, up to the 22d, the lateral had made no start at all. May 7th, it had made the feeblest kind of growth ; the lateral was dead, and was cut off. May 27th, the tree was examined for borers, but, while none were found, the tree had bled badly at the junction of stock and bud, and it looked sickly throughout. Coated it with cement and milk to keep out borers, loosened the soil, and applied a little complete fertilizer. Nevertheless, the tree lost steadily, and, July 8th, was dead. July 20th, dug it out and found that death had been from the old stock. The wood from the bud up was yet green and, apparently, healthy, but below the bud all was dead.

Tree 6. Pleasant Valley Pippin. The tree held its foliage in 1898 up to December 1st; on April 15th, 1899, the buds were starting clear up to the tip and on the 22d were opening finely. May 7th, it was in full foliage and a number of scales examined being found alive, were left to develop. June 11th, some *Clisiocampa* larvæ were noted and taken off, and on the 18th moving larvæ and a few living scales were seen.

June 19th, at 7 A. M., sprayed with 15 per cent. kerosene, with Deming pump and Vermorel nozzle, applying until the tree dripped. June 25th there were a few brown-edged leaves inside the tree at the base of the shoots, but on July 8th these signs of kerosene injury had disappeared. At the latter date no young scales were discoverable. August 15th, a little group of half a dozen white scales were discovered high up on the trunk, but no larvæ were seen. The tree was yet growing at this time, but on the 27th growth had stopped and buds were forming. September 18th no scales were noted, but leaf hoppers were present in great abundance.

October 15th, the tree was rated as fair, with good healthy foliage of which only a little had dropped. A few scattered scales were noted and a specimen of *Smilia misella.*

This tree was sprayed June 29th, 1898, and June 19th, 1899, with the mechanical mixture of kerosene and water, using 20 per cent. in the first case and 15 per cent. in the second. The tree was poor from the start, but is as good now as could be expected and certainly is not badly infested by scales.

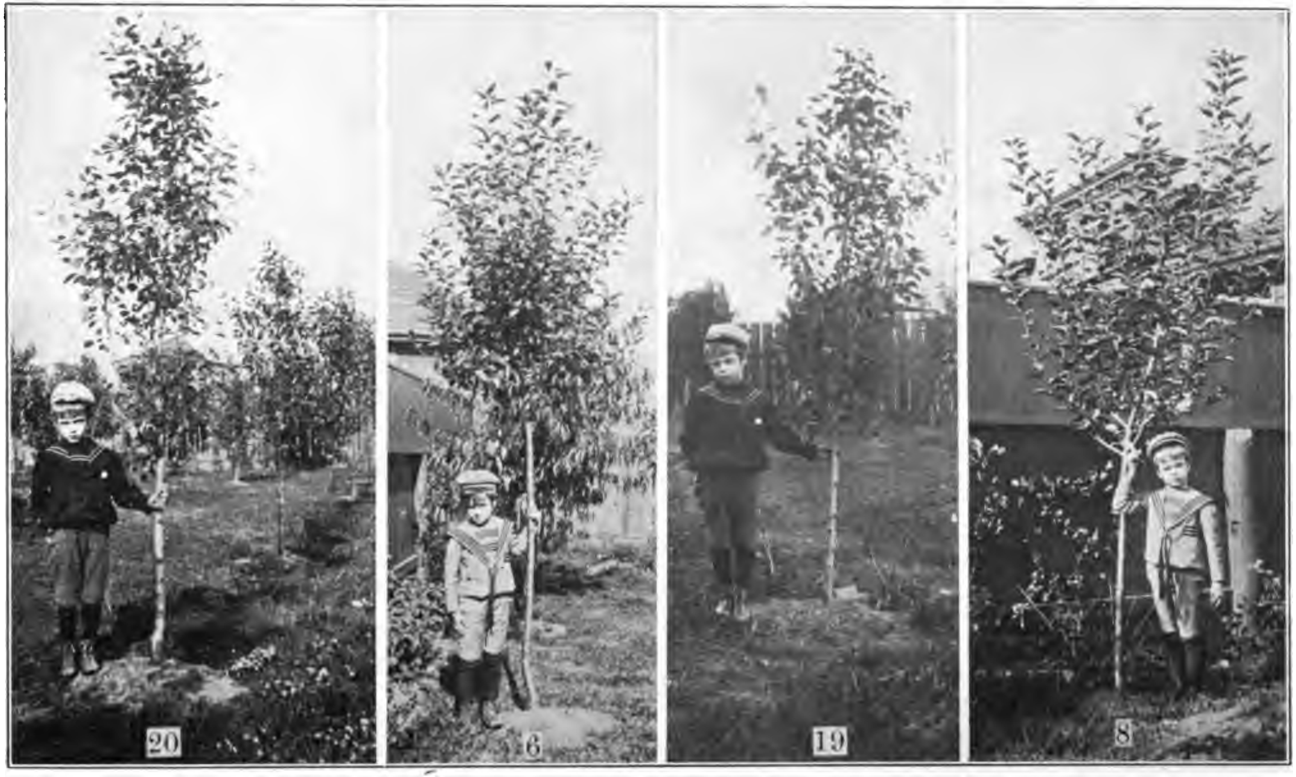

Fig. 32.

Experiment Trees: *6*, Sprayed June 29th, 1898, with 20% Kerosene, June 19th, 1899, with 15% Kerosene in Mechanical Mixture with Water, Treated with Undiluted Kerosene in the Nursery Row; *8* Sprayed with Kerosene, Undiluted, in Nursery Row, Painted with Whale Oil Soap, two pounds in one gallon of water, February 20th, 1899; *19*, Sprayed with Crude Petroleum, 20% in Mechanical Mixture, May 31, 1899; *20*, Painted with Crude Petroleum February 20th, 1899. All from photos. made about October 5th, 1899.

November 19th, about half the foliage was off, the balance mature and ready to drop. The scale situation was not different from the last note.

Tree 7. Champion Peach. This tree had practically lost all foliage except at the tips, November 20th, 1898.

February 20th, 1899, sprayed with crude petroleum undiluted, using Eclipse atomizer. The spraying was very thorough, but did not extend to the ends of the small twigs, which were to be cut off, because of the high wind. The day was warm and sunshiny, with almost a foot of snow on the ground. The tree was fully trimmed February 28th, and on March 1st I painted it with crude oil from the tips of the trimmed branches to the surface of the soil. There had been some rain and the morning was dull, some moisture standing in globules on the oily surface of the bark. Though from the color and appearance it was evident that the first application was thorough, yet the painting was as carefully and thoroughly done as if no previous application had been made.

April 15th, the buds were beginning to start; on the 22d the tree was noted as brown, greasy, crusted with dust, one side starting well, no blossom buds living or dead. May 7th, it was in full vigorous foliage, without leaf rollers or tip borers.

May 27th found a borer two-thirds grown and cut it out, applied cement and milk, mounding up against the trunk on the 28th. The tree was then in excellent condition and the equal of any other on the place. No scale was found at any of the summer examinations up to August 15th, when the tree had grown so fast that the wire of the label had almost girdled it.

No scales were found on the October 15th examination, when the foliage was a little yellow in the center of the tree, bronzing outwardly. The discoloration caused by the oil was yet visible on most of the old wood.

This tree had two good doses of crude oil, undiluted, at intervals of ten days. The first was put on with the atomizer and was as thorough as such an application can ordinarily be made. The second was painted on so as to hit every point if possible. The plant was not particularly scaly, but what was on it was killed, and it showed no trace of injury of any kind.

November 5th, the foliage was practically all off. November 19th, two half-grown scales were found on two widely-separated twigs, with no companions and no old breeders anywhere about; this is, therefore, a recent infestation and the insects were left undisturbed.

Tree 8. Grimes Golden Pippin. November 6th, 1898, moving larvæ were found after a night of cold rain, and on the 20th the foliage was yet almost all present.

February 20th, 1899, painted the tree thoroughly with whale-oil soap, two pounds in one gallon of water. Day warm and sunshiny, much snow yet on the ground.

April 15th, the tree was just beginning to start and on May 7th it was in full leaf and growing vigorously. No living scales were among those examined, but many were left to develop if they could. June 11th, leaves were curling from plant-lice attack, leaf hoppers were abundant and a larva of *Clisocampa* and of *Orgyia* were removed. How these caterpillars got in this tree I cannot surmise! No signs of recent scales were observed July 8th, but leaf hoppers were present in very large numbers. No live scales were seen August 15th, 27th or September 18th, when growth had about stopped. On October 15th it was a fine tree yet in full green foliage, with a very little scale in the middle of the tree.

The winter painting with the whale-oil soap, Good's Potash No. 3, was so effective that from a badly-infested tree on October 22d, 1898, we had October 15th, 1899, one on which scales were so scarce that it was not easy to see them.

November 19th, the foliage was two-thirds off and the scale situation unchanged.

Tree 9. Champion Peach. Foliage in 1898 dropped during the last days of November. Buds were starting well April 15th, 1899, and on May 7th was full of foliage, much of it curling from attacks of plant lice, which were quite abundant.

May 15th, sprayed the tree with crude petroleum from an Eclipse atomizer. On the 20th the tree was gradually dropping its adult leaves. They seemed to remain green and firm, but are lifeless and drop easily—choked in fact. June 1st, there was nothing to indicate that the tree had been sprayed, save that the foliage was rather thin. The oil still shows on twigs and branches, but there is nothing on foliage.

May 27th, the tree was "wormed," and two borers, three-fourths grown, were found and killed; the tree was then painted with cement and milk.

July 8th, the tree looked satisfactory in all respects, no scales were found in any stage and no signs of any kind of injury were noted.

August 15th, a few scattered scales were seen; on the 27th growth had stopped; there was some yellow foliage in the center of the tree and some of these leaves were dropping. No scales had yet set on any of the new wood. This was also the record on September 18th, when the yellow foliage was all down and the tree was in normal shape.

October 15th, it was rated as a medium tree only, foliage about ready to drop, considerable scale scattered about, most of it very recent and none of it massed. The oil was evidently put on too lightly to reach all the insects present when the spraying was made.

November 19th, foliage about all off and scales less obvious than when last examined.

Tree 10. Late Rose Peach. Foliage did not drop completely in 1898 until early in December. In 1899, the tree was well started April 15th, and some blossom buds were swelling. April 26th, there were four blossoms. May 7th, the tree was making a good growth, but much of the foliage was curled by plant lice, among whom some Syrphid larvæ were feeding.

May 20th, on a bright, cool, windy morning sprayed with a mechanical mixture containing 40 per cent. of crude petroleum in water. Used a Deming bucket pump with a Bordeaux nozzle, and fairly soaked things from all sides until the tree dripped from every leaf, and great globules of oil and water stood all over the surface.

May 26th, the majority of the leaves had dropped; yet green and plump, but lifeless and ready to come down at the least jar. None of the shoots showed injury and one fruit was set. On the 28th the foliage was almost all off and the tips of some of the lower shoots were dying. The trunk was now painted with cement and milk to keep out borers. June 4th, the tree was a sorry sight, mostly bare twigs and many of these dying. The single peach was wilted and dropped at a touch. On the 11th it was yet a terribly ragged tree, full of dead shoots; but it was getting over the shock and new shoots were starting from trunk and branches. Improvement continued so that, on July 8th, it was marked as recovering well. There was some dead wood and some twisted branches; but altogether it was much better than expected and no signs of scale were seen. August 15th, the tree was in good condition but irregular; on the 27th there were a few yellow leaves which dropped later, and on September 18th growth stopped. The tree is a cripple however, not only from the spraying but from the effects of the fence falling on it during the winter.

It should be noted that during a heavy northeast storm a section of the fence at the back of my lot was blown over, and trees 9 and 10 were bent down to the ground; 11 was bent half way over and the remainder of the series were only somewhat bent. On 9, 10 and 11 the trunks were scraped, and 10 received, altogether, the worst of it.

October 15th, the tree was yet in full foliage, though ready to strip. A few scales, mostly young, were found near the crotches, grouped as if from a single female. A specimen of *Pentilia misella* noted. There is an unusually full set of fruit buds.

November 19th, the foliage was about all off, and not above half a dozen living scales were found.

Tree 11. Late Rose Peach. Foliage half off November 20th, all down December 1st, 1898. The tree was well started and some blossom buds were swollen April 15th; a few of these were open on the 22d, and one was left on the 26th, no fruit setting. May 7th, the tree had made a good growth; many plant lice were present, among which were a few Coccinellid larvæ and parasites. Some *Epitrix cucumeris* on the leaves, and a little tip-borer. On the 27th, cement and milk was applied to keep out borers.

The tree continued in good condition, with healthy foliage and no signs of scales, until August 27th. At this date growth had stopped and a few leaves were dropping. This had ceased September 18th, and on October 15th it was marked as a good tree, foliage ready to drop and some already off. Quite a scattering of scales now found throughout the tree on the old wood, where it was not easily seen when the foliage was complete.

November 5th, the foliage was all off.

Tree 12. Fox's Seedling Peach. Foliage was not all off until December 1st, 1898. The tree was well started April 15th; some blossom buds were swollen, and these were open and in bloom April 26th. May 7th there was a good growth, some of the leaves being curled by plant lice. There were also some leaf rollers and a few leaf hoppers. No fruit set and on the 27th painted the tree with cement and milk.

June 11th, it was an excellent tree, some scales present, but no larvæ were seen. July 8th, the foliage was dense, and no signs of scale were seen on any of the new shoots. August 15th, a few scales were found on the twigs; on the 27th growth had stopped and a few leaves dropped. September 18th, the tree was vigorous and yet in fine shape as to foliage. October 15th, it was marked as a fine tree,

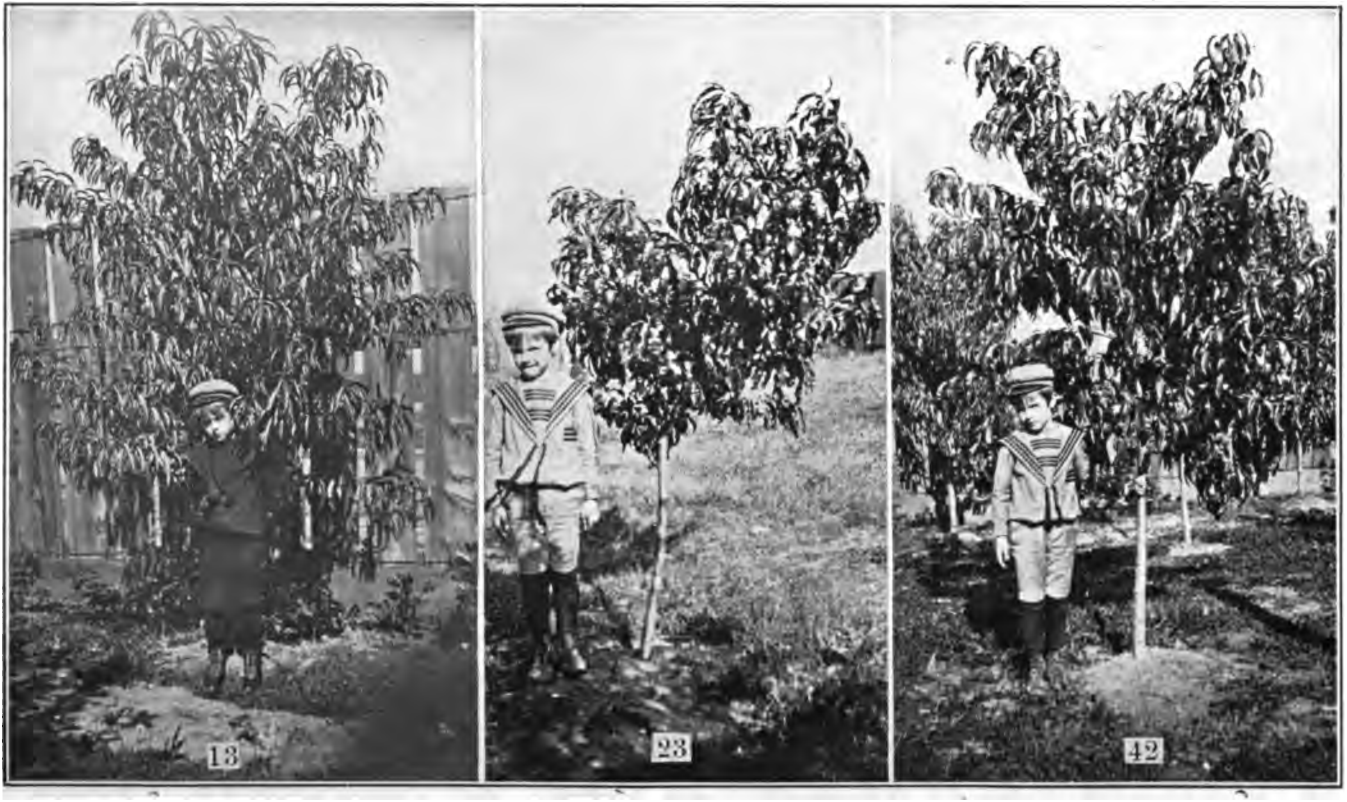

Fig. 33.

Experiment Trees: *13*, Sprayed with Crude Petroleum, Undiluted, February 20th, 1899; *23*, Sprayed with Undiluted Kerosene August 15th, 1898, with Crude Petroleum, Undiluted, September 25th, 1898, with 20% Crude Petroleum in Mechanical Mixture May 28th, 1899; *42*, Drenched with 10% Crude Petroleum in Mechanical Mixture May 20th, 1899. All from photos. made on or about October 5th, 1899.

foliage ready to drop and some already off; color good. A sprinkling of scales was found throughout the tree, most of it young.

This is another case where there was practically no increase of scale in the course of the year, in spite of the fact that no insecticide application of any kind was made.

November 5th, practically all the foliage was off. November 19th there was quite a peppering of very recent scales, many of them yet white, and a large proportion collapsed.

Tree 13. Fox's Seedling Peach. Foliage was half off November 20th, all gone by December 1st, 1898. On February 20th, sprayed thoroughly with crude oil, using Eclipse atomizer. Day warm and bright, with about a foot of snow on the ground. March 1st, the snow was gone and the trunk was painted to the surface of the ground. The trimming was done February 25th.

April 15th, 1899, buds had started all over tree, and on the 26th there were ten blossoms, the surface of the trunk brown, oily and dusty. No fruit was set from any of these blossoms.

May 7th, the tree was coated with dust on the old wood over the oil, was making a rank, vigorous growth; fewer lice than any tree in the row, no borers, no leaf rollers, but a few flea beetles.

May 27th, painted with cement and milk to keep out borers, the tree being one of the finest on the place, a rank which it held throughout the season. August 27th, growth stopped and a few leaves dropped. September 18th, this dropping ceased and the tree was in all respects fine and vigorous, second only to No. 48. October 15th, the foliage was yet fully colored and only a few leaves had dropped. No scales were found.

This tree has done remarkably well, and is one of the finest on the place. The application of the crude petroleum was very thorough, and if the material is at all injurious to peach trees this should have shown some signs. Traces of the oil yet remained in late summer, though, of course, the growth of the tree and increase in diameter have made the coating imperfect. What little scale there was seems to have been effectively cleaned out. It should also be noted that this tree had as many blossoms as any of the untreated trees; that there was not more bloom generally may be charged to the fact that I trimmed back too closely, leaving little except the larger branches, with short spurs to give shape. November 19th, all the foliage was off, and on one branch a group of small scales, some of them yet white, was found. This is almost certainly a re-infestation from No. 14.

Tree 14. Fiorentz Peach. Foliage about three-fourths gone November 20th, and all gone a few days later.

February 20th, 1899, day warm and pleasant, with much snow on the ground, first trimmed the tree carefully, then painted thoroughly with Good's Whale-oil Soap No. 3, two pounds in one gallon of water. Buds were just starting April 15th, and on the 26th there were four blossoms, none of which set fruit. May 7th, the tree was making a fair growth, there were some plant lice, among which *Coccinella 9-notata* was feeding, some leaf roller, but no tip borer. On the 27th, the tree was painted with cement and milk, the foliage was then good, and the tree was satisfactory in all respects.

Up to August 15th no new scales were seen ; but on that date scattered examples were noted on trunk and branches ; none on the new shoots. The tree was now decidedly inferior to No. 13, and on the 27th, when growth had ceased it was much smaller, with much thinner and more yellow foliage.

October 15th it was rated as only a medium tree, foliage rather thin and much of it dropped, considerable scale on both trunk and branches, but in distinctly better condition than at the same period last year.

In this entire series of peach trees from 9 to 14 inclusive, almost every tree had a few blossoms and none set fruit, whether treated or untreated. No. 13, treated with crude oil, had more blossoms than any other, probably due to the greater vigor of the tree, but it indicates that the oil did not kill the buds, applied late in February.

November 19th, all the foliage was off and on the trunk and old branches there is considerable scale ; much of it recent. The new wood is less infested ; but I consider it bad enough now to make a subject for winter treatment.

Tree 15. Japan Golden Russet Pear. All the foliage was gone before November 1st, 1898. April 15th, 1899, buds were swollen all over the tree, and between the 26th and May 7th the tree was a mass of flowers, which indicated a set of fruit at the latter date. May 21st, fruit had set generally, and on June 11th there was a goodly quantity and the foliage was healthy, though no long shoots were making. June 18th, there were many active larvæ and some recent scales, and on the 19th sprayed thoroughly with 15 per cent. kerosene, using the Deming outfit and Vermorel nozzle. On the 25th, quite a number of the leaves were black-spotted or marked along the edge or the veins, regularly or irregularly. On July 8th, quite a number of these leaves had dropped, but some of the remaining foliage was yet

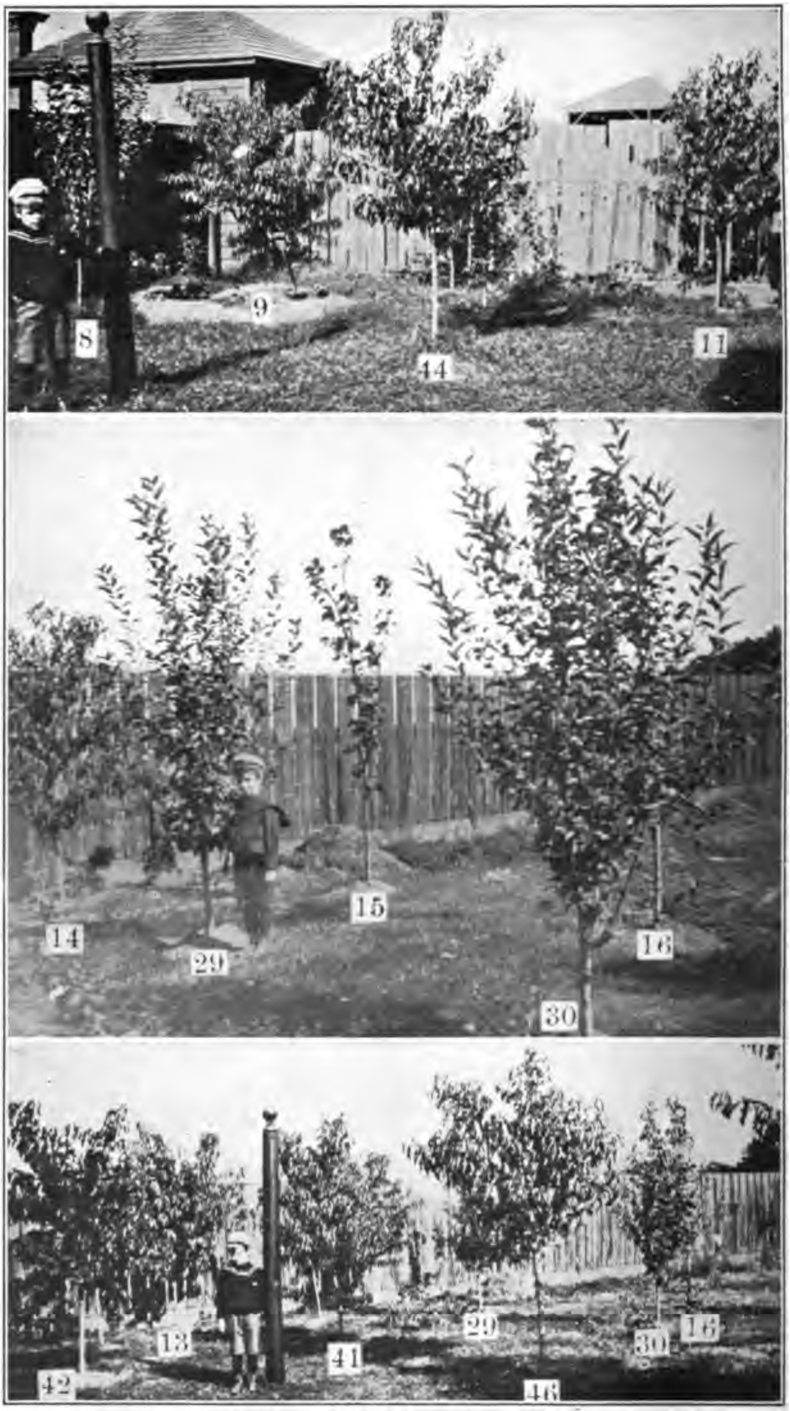

Fig. 34.

North Corner of Experiment Orchard, showing Trees 8, 9, 11 and 44; East Corner showing Trees 14, 15, 16, 29 and 30; *14*, Painted with Whale Oil Soap, two pounds in one gallon of water, February 20th 1899; *29*, Sprayed with Kerosene, Undiluted, June 25th, 1898, and with Crude Petroleum November 1st, 1898; *30*, Sprayed with Crude Petroleum November 1st, 1898; Larger View of the East Corner, showing the Trees Numbered for Purposes of Comparison. All from photos. made on or about October 5th, 1899.

spotted. The fruit was growing fairly, but there were no growing shoots. No new scales were seen.

August 15th, scattered white scales were seen on the trunk, and the fruit was becoming infested by the larvæ of the codling moth, which bored in from the side. On the 24th, removed 6 pears, weighing 18 ounces, and on the 26th, took off 31 pears, weighing 4 pounds 15 ounces ; altogether 6 pounds 1 ounce for 37 pears, which makes an average of 2.67 ounces each. The pears were ripe, but not nearly full grown. There were too many for the small tree, but the entire crop was left on, because the tree had been sprayed with oil, and also to serve as a basis of comparison with No. 16. On the 27th all the fruit was off, growth had stopped and the foliage was in good condition.

September 17th, quite a number of white and half-grown scales were seen. October 15th, the foliage was mostly off and the remainder yellow, while there were a considerable number of scales on the tree, more than a year ago in fact. September 23d, the foliage was practically all off, and the scales were breeding at a lively rate. Larvæ were more abundant than at any time during the season, and bid fair to give a general infestation before the season closed.

This tree has borne a crop of fruit, the buds seem well set for 1900, and to test the effect of crude oil upon recently-formed and yet not entirely mature fruit buds, the tree was thoroughly painted with crude oil October 25th, at 4 P. M.; day sunshiny, warm, a little hazy. All the leaves were first stripped off and the painting was done over the raw surfaces.

Tree 16. Japan Golden Russet Pear. At the end of the season of 1898 this tree was not so good as No. 15, and there were many scales at the examination made October 22d. A later examination made November 20th, found the tree bare, many white though collapsed scales present, no moving larvæ but living specimens under adult female scales.

April 15th, 1899, the buds were swollen all over the tree, it was a mass of buds on the 26th, coming into full bloom a day or two thereafter and continuing until May 7th, when the blossoms were about gone and fruit was setting. On the 21st it was evident that there was a full set of fruit and also a very large set of living scale. May 28th, painted every particle of last year's wood with crude petroleum, using a stepladder to get to the top. Foliage and fruit were avoided so far as possible, but the base of the shoots was as fully treated as was possible under the circumstances. The object was to hit every particle of wood not of this year's growth, and I thought I had done it thoroughly. The upper part of the tree was even more scaly than I had supposed, and generally the insects were alive.

On June 11th the fruit was holding well as were also the leaves, though there were no growing shoots. Not a leaf or a fruit had dropped as the result of the oil application. On the 18th I noticed a few scales of recent set on one twig, part of which I had evidently missed. July 8th, I saw neither live scales nor larvæ, but on August 15th there were a few scattered live scales. At this time the fruit was decidedly larger than on tree 15, but it was also getting wormy. The slender branches now bent over so much that one was propped.

August 24th, there was a heavy rain with a twisting wind that broke one of the smaller branches carrying 10 pears, weighing 2 pounds 6 ounces. On the 25th, removed three other wormy pears, weighing 9 ounces, and on the 26th removed the balance of crop, or 23 pears, weighing 5 pounds 1 ounce. Altogether, the tree practically matured 36 pears, weighing 8 pounds, an average weight of 3.55 ounces each. The fruit was undersized and the tree carried more pears than it should have done, but practically everything was left on, that there might be a satisfactory basis for comparison with No. 15, and for determining the amount of injury, if any, that could be charged to the oil. As it was, the tree had within one as many pears as No. 15, while they averaged almost an ounce more in weight.

All growth had stopped August 27th; a few white scales were noted September 17th, and on October 15th the foliage was mostly yellow, ready to drop, but no live scale was seen. On the 23d practically all the foliage was off, but I found no live scales.

Two things are fairly to be inferred from the summer's work on this tree—the first, that all the bark of the previous year may be covered with crude oil in early summer without in the least interfering with the ability of the tree to mature its fruit; the second is, that while larvæ may set on the treated wood, they find it practically impossible to develop beyond the white stage.

November 5th, the foliage was all off, and now a little group of live scales was seen at the main crotch.

Tree 17. Keiffer Pear. Only a few leaves remained November 20th, 1898; but there were great numbers of half-grown scales; most of them dead.

April 15th, 1899, buds were beginning to force and on May 7th the tree was in full leaf but had quite a number of short spurs that had already stopped further growth. There were a few leaf rollers and a very few scales. May 20th, bright, cool, windy morning, I sprayed with a 40 per cent. mechanical mixture of crude oil and water, using Bordeaux nozzle. There had been an overflow of oil into the water in carrying the pail about and the water was thoroughly saturated with oil. Everything was sprayed on and the tree was thoroughly wet; but the proportion of oil cannot be accurately told. There was enough, however, to discolor all parts of the tree. May 26th, an occasional brown spot was noted on the leaves, which I take to be due to the oil, but there was no other sign of injury. June 18th, there were a few spindling shoots, most of which had stopped growth, some tips were curled a little by plant lice and a few scale larvæ were noted. July 8th found a half-grown live scale, and on August 18th counted five white scales and no larvæ. On the 27th the foliage was good though small, and on September 17th the tree was fair, the buds forming nicely. October 15th, the foliage was mostly off, but what remained was fair in color. There were a few, much scattered live scales. Quite a number of pear psylla in the pupal stage were noted about the terminal buds, their presence revealed by the action of a *Vespa* that appeared to be feeding there. On the 23d the foliage was about all off, and no breeding scales were noticed.

November 19th, foliage all gone. The scale situation had not changed and an adult pear psylla was seen.

Tree 18. Keiffer Pear. Only a few odd leaves remained November 20th, 1898. On April 18th buds were just beginning to force, it was in full foliage May 7th, with some spurs already at a standstill; a few leaf rollers and some scales noted.

July 8th, it was a fair sort of tree with little spindling growth and no scale apparent on the new wood. August 15th, white scales were scattered here and there on the old wood. On the 27th the foliage was good though small, all growth having stopped long since. September 18th buds were forming well, and I found no obvious scale on the new wood.

October 12th the foliage turned red and brown and much of it was dropping, especially from the tip. On the 15th the leaves were mostly off, the remainder ready to drop at a touch; there is some scale all over the tree, but not much. On the 23d the tree was nearly bare, and no breeding scales were noticed.

It is notable that while no treatment was given this tree, the scales have barely held their own, and that in this respect the history of

1898 is repeated. The tree is not a good one, though its ill-health is not in any way chargeable to the scale.

November 19th, all the foliage was off, the scale situation was scarcely changed except that a few collapsed white sets were noted, and the tree now shows evidence of the presence of a sinuate pear borer. None have issued from the trunk, hence the infestation has come in since the tree has held its present place.

Tree 19. Keiffer Pear. Foliage was all gone November 20th, 1898, on which date several larvæ and young scales were observed.

April 15th, buds were beginning to force, and on May 7th there was a good coat of foliage, though some of the spurs had already stopped growing. There were some leaf rollers and a few live scales. On the 31st, a bright, sunny, warm morning, sprayed with crude oil and water, mechanical mixture, containing 20 per cent. oil.

June 11th, the leaves were pretty well spotted by the oil but no other injury was apparent. The growth was loose and spindling, and most of it had stopped.

July 8th, one shoot has resumed growth, but no other change was noted, and no scale larvæ or recent sets seen until October 15th, when the tree was noted as only fair, foliage yet green, but much of it already off. No live scale visible.

The tree has not improved much during the year, except in the matter of scales, which seem to have been cleared off. November 5th, the foliage was nearly all off; it was all gone on the 19th, when no appearance of recent scales could be found.

Tree 20. Keiffer Pear. November 5th, 1898, crawling larvæ and recent sets were yet seen; on the 20th, with foliage all gone, many females had live larvæ beneath them, as if breeding might go on for some time yet.

February 20th, 1899, painted the tree with crude petroleum from the tips to the surface of the ground. Used a stepladder to get to the top, and painted every spur and bud as completely as possible. Day clear, bright, sunshiny.

April 15th, only the top buds were starting and the tree seemed on the whole a little later than its neighbors, and so it remained on the 26th, when it had three blossom clusters. May 7th, it had caught up, the bloom was done and no fruit was set. June 11th, was making the usual spindling growth, most of which had stopped, and it was now a little the best tree of the series.

All growth had stopped July 8th, when it was rated a decent tree, and the half-grown scales of the previous year apparently were dead.

August 15th, I noted two or three white scales scattered in different parts of the tree, but these had disappeared on the 27th, when the foliage was marked good, though small. Nothing new was noted September 18th. October 15th, it was the best tree of its series, foliage green, most of it yet on, plenty of evidence of the oil yet noticeable and no signs of live scale.

This was the worst-infested tree of the series last fall; is now apparently free from live scales and has become the best of its kind, which is not saying much. All the foliage was off November 19th, and no scales were seen.

Tree 21. Keiffer Pear. Foliage was not yet all gone November 20th, 1898, when many new and half-grown scales were noted on the tree, breeding having been very free during the month.

February 20th, 1899, a bright, sunny day, painted the tree with Good's whale-oil soap, two pounds in one gallon of water, put on thoroughly. April 15th, buds were forcing at the top of the tree; May 7th, it was in full foliage; May 28th, it was growing vigorously, but there had been no blossoms, and on June 11th the spindling growth had stopped. July 8th, it was a fair tree, without growing shoots, no scales, no larvæ and no recent sets on new wood.

July 21st, found a brood of *Hyphantria* just started and cleaned it out. August 15th, there was plenty of new scale on the trunks and lower branches, and larvæ were now coming upon the new wood. Destroyed two small nests of *Hyphantria*, and on the 27th a new shoot was making from one that had stopped growth earlier in the season. September 18th, all growth had stopped, and on October 15th it was rated as a very fair tree, foliage of fair color, only a little off, though ready to drop, scale much less evident than it was earlier in the season, unless it is so high up as not to be within easy seeing range. Altogether, so far as the scale is concerned, the tree is in about the same situation that it was last year, all the heavy breeding having occurred in late August. All foliage was off November 5th. On the 19th scale was found all over the tree and quite considerable low down on the old wood.

This series of Keiffers is unsatisfactory so far as the trees themselves are concerned, because they seem to lack vigor and the growth is very scant, not what a tree of this variety ordinarily makes. It is probable that the soil conditions are not favorable. Though these trees were partly in bloom when received from the nursery, only one of them had any blossoms this year, and that was the one painted with crude petroleum. So far as the scale feature is concerned, the trees altogether untreated seem to be no worse than the one treated with soap during the winter, while the one treated with crude oil is at the time of writing apparently free from them.

Tree 22. Michigan Peach, No. 141. This tree was sprayed with crude petroleum November 1st, 1898, while some foliage yet adhered; on the 5th there did not appear to be any ill effects, the foliage holding quite as well as on the other trees, and not until the 20th was it about all off.

April 15th, 1899, the buds were forcing all over the tree and it had made a good start May 7th, on which day there were both leaf rollers and plant lice in some numbers. May 27th, cement and milk was applied to keep out borers; at this time the tree had good healthy shoots and was the peer of any other in general condition so far as was apparent from superficial examination. June 11th, it was decidedly off color, and growth seemed to have stopped. It kept getting worse until July 15th when it was dead, though some leaves were yet adherent, and the shoots seemed plump and were green when cut. Dug up the tree July 20th and found the root and crown dead to the bud, the trunk and all above sound in appearance when cut. There were no feeding roots, and it looked as if the tree had never had any real hold in the ground.

November 7th, set a Paradise Sweet Apple. The tree is large, overgrown, of excellent shape, pretty well covered with scale and rather badly injured. It came out of a scaly block of left-overs, and the digger was run very close to the rows, so that the larger roots are very short, badly torn and the small roots few in number. The top was split in transit, so the tree is in bad shape and may not live. November 16th, covered the break with grafting wax and tied the branches in place.

Tree 23. Pride of Franklin Peach. This tree was treated in 1898 with undiluted kerosene August 15th, and on September 25th with crude petroleum undiluted. I noted at the end of my account: "This tree has had hard usage, and that it remains in so good a condition is matter for surprise. The condition in which it comes out next spring will be interesting."

April 15th, 1899, the buds were forcing; on May 7th it was well started but the foliage yellow and unhealthy. The tree was lopsided and of no account as such, but was preserved for experiment. On May 27th it was examined for borers and painted with cement and milk to prevent infestation. On the 28th it was thoroughly sprayed with 20 per cent. crude oil in water with Deming emulsion pump and Vermorel nozzle; morning bright, warm and sunny.

June 11th, the tree was very small, with light-colored foliage and very slow-growing shoots; but it had improved in color, decidedly, and was in good condition July 8th.

August 15th, it was in excellent condition, and for the first time in the history of the tree some scattered white scales were noted. On the 27th growth had stopped, but the foliage was perfect and none had dropped. October 15th the foliage was yet perfect, but mature and easily stripped. It was rated as a poor, lopsided tree, but no live scales were noted and no signs of recent breeding. The tree has a small set of fruit buds and so far as external appearances go should do well next year.

This tree was free from scales when set and remained so all last year. A few larvæ of the second brood were apparently carried over to it in August, but these have not bred so far as I can see. All the applications made on this tree were merely to test the effect of the insecticide on the foliage.

November 19th, all the foliage was off and no live scales were seen.

Tree 24. Pride of Franklin Peach. The foliage did not all drop in 1898 until December 1st, and on April 15th a start was made, a single blossom appearing on the 26th. No fruit set, and on May 7th the tree had made only a fair start and had more tip-borer and leaf roller than any other on the place. Cement and milk was applied May 27th, and on June 11th it was a fair, healthy tree, with long shoots of fine-colored foliage. July 8th, the growth was feeble and the foliage was getting ragged and torn. Growth stopped altogether August 27th, and on September 18th the foliage was quite thin. October 15th it was red and discolored, some already off and all of it ready to drop; the tree, as a whole, only fair.

This tree has been free from scales from the beginning and yet remains so. All the foliage was off November 19th.

Tree 25. Michigan Golden Drop Peach. All the foliage was off November 25th, 1898.

February 20th, 1899, painted with Good's Potash Soap No. 3, two pounds in one gallon of water; day bright and sunny. The application was made to test its effect on the "curl," and perhaps on the fruit buds, if any.

The buds had barely stirred April 15th, and the tree had only fairly started May 7th, none of the foliage being yet full grown. Tip-borer and leaf roller were plentiful, scarcely second to 24 in this respect. May 27th, applied cement and milk to keep out borers, and on the 28th it was noted as a poor tree, with thin, scant foliage, bad in color and apparently stopped in growth. June 11th, it was marked a little weakling, and on July 8th there were only little tufts of leaves, scarcely enough to mark it as yet possessing life. August 15th, it was partly dead and literally filled with *Scolytus rugulosus*, the fruit-bark beetle. The tree was cut August 20th below the surface and burnt, to destroy the Scolytids. The root and all below the bud was dead throughout; the trunk yet had some life. There was no scale on this tree at any time, and it died exactly as did No. 5 and No. 22.

November 7th, set a small apricot of rather scrubby growth, but otherwise clean and in good condition. This tree is to serve simply to test the effect of insecticides on this kind of fruit, though it is not grown commercially, so far as I am aware, in New Jersey.

Tree 26. Michigan Golden Drop Peach. All the foliage was gone November 25th, 1898; buds had barely started April 15th, eight blossoms were out April 26th, and on May 7th the tree had barely made a start, none of the leaves being full grown, the blossoms gone and both tip-borer and leaf roller present. May 21st, one fruit had set, and on the 27th the trunk was painted with cement and milk, to keep out borers. June 11th, it was noted as a little weakling, growth stopped, apparently about ready to give up the ghost. There was no improvement July 8th, and on August 15th it was dying and infested by the fruit-bark beetle. August 20th the tree was cut off below the surface and burnt, to stop the Scolytid breeding. The tree had died just like No. 5, No. 22 and No. 25, and this death of an untreated tree relieves the insecticide applications of the charge, which might otherwise have been made, of being the cause of death. The entire series of trees from No. 22 to No. 28, inclusive, were grown in North Jersey from Michigan buds on seedlings from Tennessee pits. None of them made a satisfactory growth, all of them developed the "curl" in 1898, and three of them are now out.

November 7th, set a small though good nectarine, to serve for insecticide experiments. There are no scales or other pests on this tree at present.

Tree 27. Cratægus. This was a Golden Drop Peach in 1898, taken out as an excellent specimen of the effect of leaf curl. A *Cratægus*, with some scale of recent origin, was set November 5th, though not dormant and with much foliage yet on. Some leaves were still on November 20th, and all were not off until well along in December.

The tree started well in April, 1899, and made a good growth, no larvæ or recent scales being seen until July 8th, when some half-grown forms indicated a little breeding during the latter part of June. August 15th, scales were plentiful, and some of them had already set on the new wood. On the 27th the tree was yet growing, but no longer vigorously, and on September 15th the scales were breeding merrily and the tips were badly curled by plant lice, which were then plentiful. October 15th, scales were present in all stages ; sexed plant lice were plentiful and their eggs were beginning to be numerous. October 23d, while the tree was yet in full foliage it was a mess from scales and plant lice, the eggs of which were now present in great quantity.

November 19th, foliage yet complete, though black from honey dew and fungus ; plant lice yet laying eggs, which fairly coat the twigs and crotches ; scales yet breeding, yellow and white scales abundant, but no moving larvæ seen.

Tree 28. Early Michigan Peach. The foliage was practically all off November 20th, 1898, and buds began forcing April 16th, 1899. A very decent growth had been made May 7th, only a little leaf roller being present, and on the 27th applied milk and cement to keep out borers. Growth continued in good shape until August 27th, when it had stopped ; the foliage then bad in color and ragged, with purple speckles, though not yet dropping. September 18th, the foliage was about ready to drop, and on October 15th it was rated a rather poor tree, much foliage off and the balance about ready to drop.

This tree was free from scale when set and has remained so. It served for a kerosene and rosin experiment in 1898, but all the shoots injured by that application came off in the trimming ; the tree is now sufficiently symmetrical, and while in no way first-class it is much the best of the series to which it belongs.

November 5th, stripped what little foliage yet remained on the tree. November 6th, painted thoroughly with crude petroleum, care being taken to cover all the fruit buds and each little twig was separately painted. The set of fruit buds is heavy, and the object of this experiment is to determine the effect of the crude petroleum upon them at this time.

Tree 29. Gravenstein Apple. In 1898 the tree was sprayed with kerosene, undiluted, June 25th, and on November 1st it was sprayed with crude oil, undiluted, while yet in almost full foliage. November 5th, no appearance of injury had developed, and on the 20th leaves were not more than half off, while the tree was brown and greasy throughout. Not until well along in December was all the foliage off.

In 1899 the buds were just making a show April 15th ; on the 22d some leaves were already well developed, and on May 7th it had a good covering of clean, healthy foliage, a little leaf curl by an Aphis, not *mali*, being noticeable.

May 28th it was one of the finest apples on the place, some of the shoots already over a foot in length. June 11th, many leaf hoppers were on the foliage and plant lice were curling some of the leaves. On the 18th the plant lice had largely disappeared, and on July 8th the foliage was so dense that examination was somewhat unsatisfactory, but no scales were seen on the new growth. Leaf hopper injury increased steadily, and on August 15th I found a few white scales very low down on the trunk. Growth stopped September 18th, and the tree was marked October 15th as fine and vigorous, in full foliage, which was badly spotted by leaf hoppers. Quite a number of plant lice were also present, but I could find no live scale.

November 19th, the foliage was thinning out, and I now found a very few breeding scales surrounded by groups of white or recent sets, always in a crotch.

Tree 30. Grimes' Golden Pippin. Sprayed with crude oil November 1st, 1898, only the trunk and larger branches being aimed at. On the 20th the foliage was about half off, and no appearance of injury was noted, though the oily surface was becoming covered with dust.

The tree was trimmed March 1st, 1899, had scarcely made a start April 15th, but on May 7th had a fine coat of clean, healthy foliage, free from plant lice and on the 28th it was in fine, vigorous condition, second only to No. 29, with foliage as thrifty as could be desired. June 11th, there was considerable leaf curl from plant lice and many leaf hoppers were spotting the foliage, the louse infestation being very bad on the 18th. The growth was nevertheless, excellent on July 8th, and while leaf hoppers had increased, the lice had not.

Some white scales were noticed low down on the trunk August 15th, on September 18th all growth had stopped, and on October 15th it was rated a very good tree, in full if spotted foliage, second to No. 29 only in size. At this latter date isolated scales were seen in the center of the tree, but nothing at all on the new shoots.

November 19th, the foliage was yet nearly complete and the scale situation unchanged, no recent sets noted.

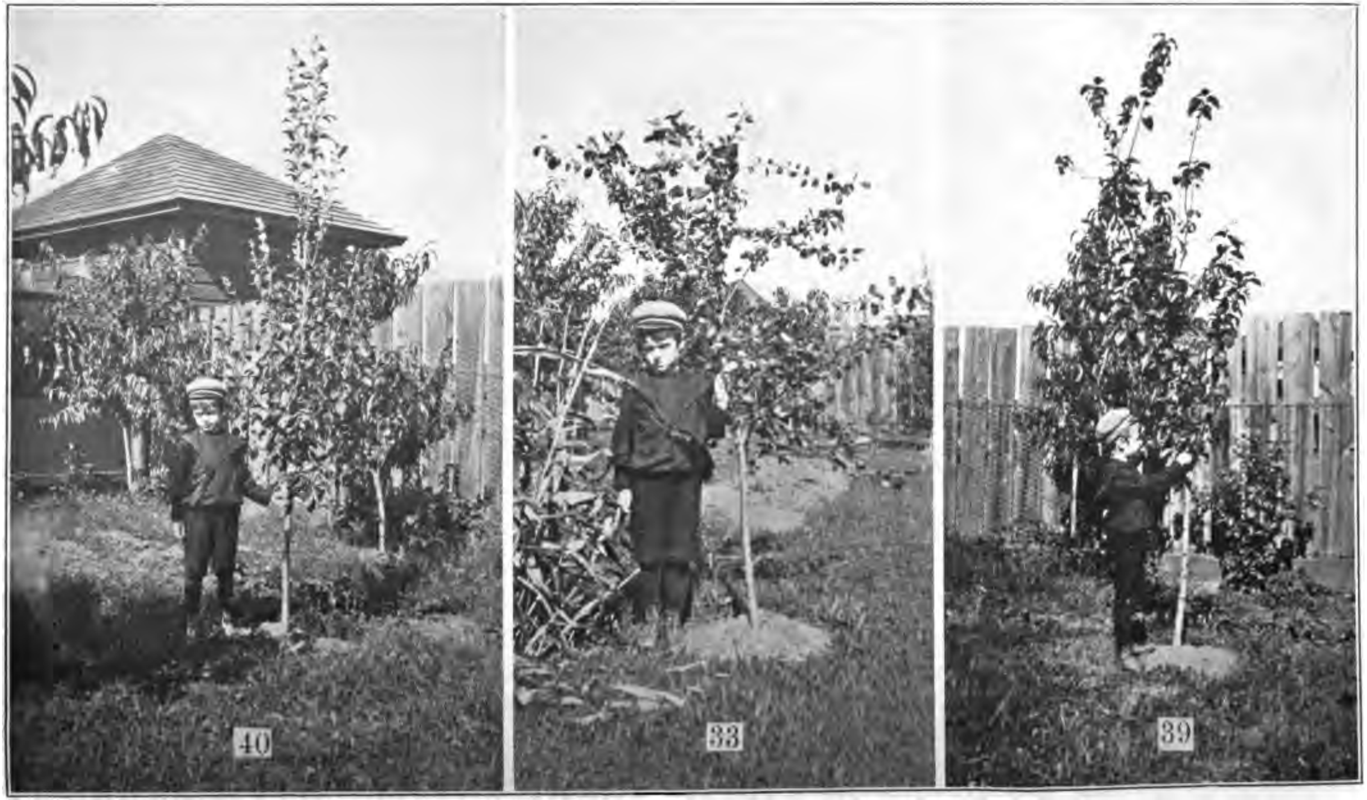

Fig. 35.

Experiment Trees: *33*, Plant Louse Experiment Tree; *39*, Painted with Crude Petroleum February 20th, 1899, Partly Stripped by Yellow-necked Caterpillars; *40*, Untreated Tree, scaly when set and no worse now than in the Spring of 1898. All from photos. made on or about October 5th, 1899.

Tree 31. Willard Plum. Died in 1898 and replaced October 28th, by a clean Paragon chestnut. The tree started early in May, but growth had already stopped June 11th, and late in that month the tree was dead.

It was taken out July 10th, and on October 21st a clean German prune was set in its place.

Tree 32. Seneca Pear. Treated in 1898 with the kerosene and rosin mixture, in which some copper salt was accidentally added. Some foliage was yet hanging on November 10th, but the tree seemed to be dying at base.

Buds began to swell April 15th, 1899; it had a coat of clean, healthy foliage May 7th, with some shoots over four inches in length, well colored and doing unexpectedly well under the circumstances. June 17th, larvæ and white scales were seen; June 18th, larvæ were setting to the tips of the new shoots; June 19th, sprayed with a 15 per cent. mechanical mixture of kerosene and water, with Deming Vermorel nozzle; June 20th, the heavy storm already mentioned in the introductory notes broke the tree at the surface of the ground; June 21st, examined the tree carefully, found no larvæ, all the white sets collapsed, but could say nothing definite about the few specimens that had reached the gray stage. The tree was dug out July 8th.

September 29th, set a scaly Lawrence pear not yet dormant. It was a "left-over" from a purchased lot, heeled in during the summer, and it had nothing to recommend it except the scales. Foliage was all off October 15th, but there were no breeding scales.

Tree 33. Unnamed Apple. November 10th the leaves were dropping fast, and plant lice in great numbers were mating and laying eggs. This egg-laying continued until the beginning of December, and when late in February the tree was pruned, most of the badly-infested shoots were left on, making a sprawly, unsatisfactory form, the object being to study the history of the apple lice in this immediate locality.

The buds were beginning to start April 15th, and on that date the plant lice were hatching from the eggs; one or two on every bud. On the 26th lice were increasing rapidly, and several had second-molted. May 7th, lice were all over the tree, and leaves and shoots were curling badly. Shoots were cut almost daily to preserve the history of the species, and this, continued throughout the season, made it a terribly ragged specimen.

May 10th, clear, bright sunny morning, sprayed with crude oil from Eclipse atomizer some of the lower twigs and branches, to note the effect on tree and plant lice. The application was thorough so far as it went, and on the 11th all the insects were dead, the leaves were marked with transparent oily spots, but the growing tips seemed to be all O. K. On the 15th matters were no worse except that two soaked tips were dead; the leaves on the unsprayed portion looked just as badly from plant lice injury as the others did from the oil.

June 11th it was a badly used-up tree, but was doing nobly under the circumstances; some Syrphid and Coccinellid larvæ were now at work, and on the 18th a disease of some sort was turning the insects black. June 28th, the Aphids had taken a fresh start, and most of the tips were now horribly infested, full-grown wingless forms wandering everywhere on the trunks and branches. Disease, parasites, Syrphid, Coccinellid and Chrysopa larvæ were all at work without much apparent result July 28th; the constant cutting of shoots has made a very curiously-shaped tree, the youngest tips being much the most infested.

August 15th an excellent crop of second-brood scales was setting; the tree was a sight, but was doing the best it could under the circumstances, and up to September 18th shoots were growing in spite of plant lice and scales. October 15th, it was an irregular straggling tree, full of egg-laying lice, eggs and scales in all stages.

The tree has really done remarkably well under the circumstances, and that it is alive at all under the unchecked scale and Aphid attack, supplemented by the constant cutting of shoots for specimens, is proof of its vigor and firm hold on the soil.

November 5th, scales were yet breeding, though slowly, some Aphids still on the tree and eggs are being added to.

November 19th, lice were yet ovipositing, and much foliage was yet on the tree. Scales swarming in all stages, from moving larvæ to breeding females.

Tree 34. Seneca Pear. The tree had during the summer of 1898 two doses of kerosene and one of crude oil, all undiluted, and on November 1st it was again sprayed with crude oil. On the 20th all the foliage was off, and except for the oily brown appearance the tree presented nothing unusual. Buds were swelling April 15th, 1899; May 7th it was making a nice, healthy start, with only a little leaf roller, and on the 28th it was in excellent condition, foliage perfect, some shoots already fifteen inches long. June 11th some of the shoots had stopped growth; July 8th the foliage appeared lighter than it should, and on the 16th it was noticeably off. At this time the tree seemed hidebound and the bark was splitting. I slit the

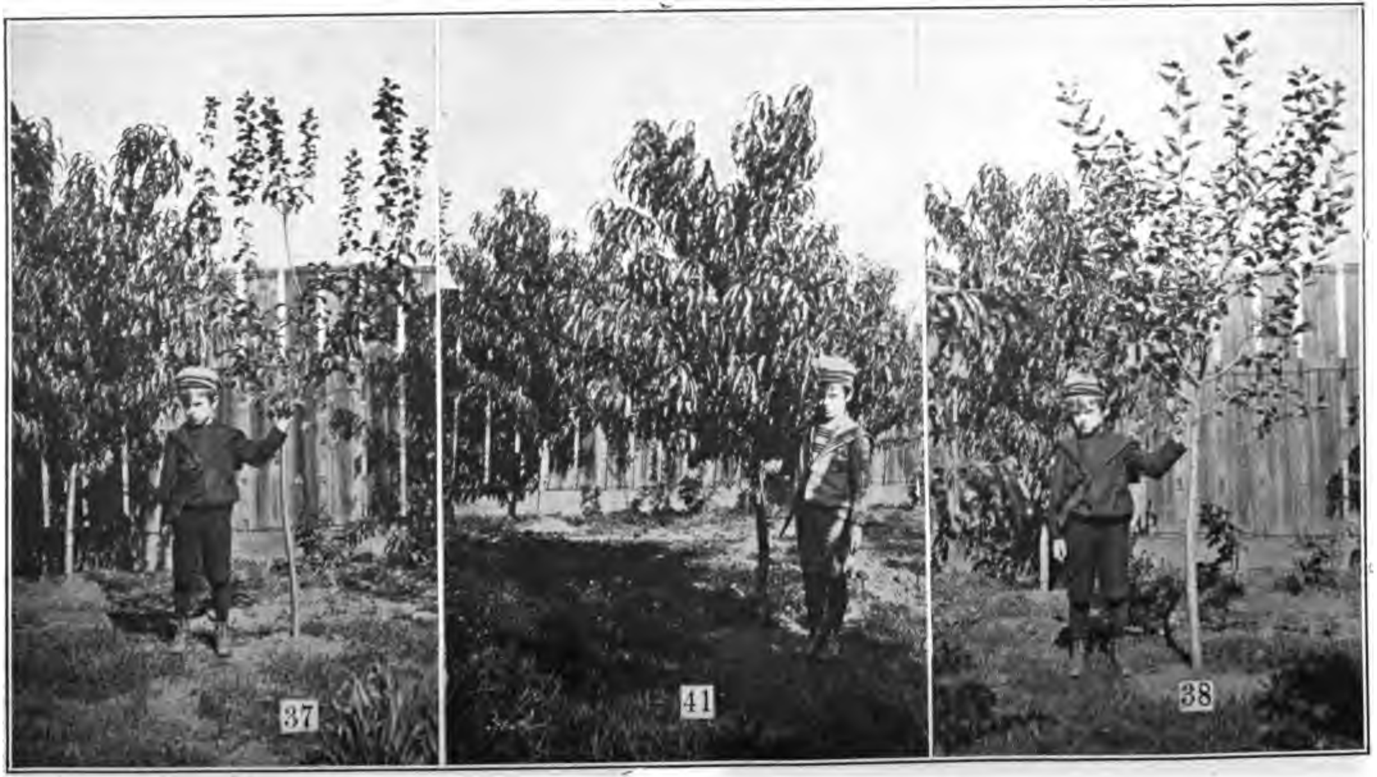

Fig. 36.

Experiment Trees: *37*, Sprayed with 20% Kerosene in 1898, Painted with Crude Petroleum, Undiluted, February 20th, 1899; *38*, Kerosene-treated in the Nursery, Sprayed with Crude Petroleum Summer of 1898, Drenched with 40% Crude Petroleum May 20th, 1899; Sprayed with 15% Kerosene June 19th, 1899; *41*, Painted with Crude Petroleum February 20th, 1899. All from photos made on or about October 5th, 1899.

trunk and all the old wood, making one or two longitudinal cuts, according to size. On August 15th, the tree seemed yellow and lifeless, without energy, on the 27th the foliage was red and beginning to drop, no healing of the edges of the slits perceptible. September 7th it was brown and the shoots wilted, on the 17th it was dead. On the 29th I took it out and set a scaly Lawrence, similar to that put in the place of No. 32, and with the same history.

No live scales were found at any time in 1899 on the Seneca pear, and no signs of breeding of any kind. Of course, this tree has had extraordinarily severe treatment; but I am not at all certain that the oil alone was responsible for its death. I have seen several trees of this variety free from scale and not the subject of insecticide experiments that acted much as this did, *i. e.*, grew well for a year or two and then stopped, remaining stationary a year or two and then dying because, apparently, unable to grow more. The scale attack last year and the four oil applications undoubtedly hastened matters very considerably in this instance.

. *Tree 35.* Japanese Walnut. Made a slow start May 7th, and continued to grow normally until late in September. October 15th, some of the foliage was frosted and brown, and on the 23d all of it was brown and dry. The tree was clean when set, and remained so throughout the season. All the foliage was off November 5th.

Tree 36. Apple, unnamed. Buds were just opening May 7th, 1899, and on June 11th it was growing fairly, some plant lice curl at tips. June 18th, this injury became more serious, and on the 19th sprayed with 15 per cent. kerosene, Deming sprayer and Vermorel nozzle. On the 25th the lice were pretty well gone, except on two or three leaves, and this was also the record July 9th, when the tree was growing fairly. This growth continued until late in September, and on October 15th it was a small tree of good growth, in good foliage, somewhat spotted by leaf hoppers and without scales. November 19th, it was yet in full foliage.

This tree was cleaned by an application of kerosene last year, and remained clean all season.

Tree 37. Spaulding Plum. This tree was sprayed with 20 per cent. kerosene in 1898, and did not lose all its foliage until late in November.

February 20th, 1899, painted the tree with crude petroleum merely to test its effect; the day bright, clear and dry, with 18 inches of snow at the base of the tree. Buds were swelling April 15th, and on

May 7th was making a healthy growth of fresh, well-colored foliage, some shoots 3 inches in length. Growth continued without adverse developments throughout the season, and did not cease until late in September. October 15th, it was rated a very fair tree, foliage yet green, very little of it off. No scales were seen at any time during the season.

November 19th, foliage was about two-thirds off.

Tree 38. Baldwin Apple. Kerosene-treated in the nursery, treated with crude petroleum in the summer of 1899, foliage all off before December 1st.

April 15th, 1899, the tree had started well but not evenly, and on May 7th it was making a good healthy growth, a few leaves curled by a mealy plant louse. May 20th, a bright, cool, windy morning, drenched the plant with 40 per cent. crude oil, using Deming pump and Bordeaux nozzle. The leaves were literally soaked, and great globules of the mixture stood on the surface and rolled off the ends; it was impossible to spray more thoroughly, but a goodly portion of the mixture did not get to the surface of the leaves or shoots at all, owing to the dense clothing of fuzz or hair and the relatively coarse spray.

On the 26th there was no sign of injury except an occasional brown spot; on June 11th the effects of the oil were visible browned leaves, none of which had dropped, however. Many shoots were curled at this time by plant lice. June 18th, a few new scales were set on the trunk, on which there is no trace left of the crude oil application of May 20th. On the 19th, sprayed with 15 per cent. kerosene mixture, Deming Vermorel nozzle, as thoroughly as possible, the fuzzy clothing making it very difficult to wet everything. On the 25th, the edges of some leaves were burned and there was a little intensification of the crude oil injury. July 9th the plant lice were all gone, but leaf hoppers were bad. No scales of recent set were seen anywhere. August 15th noted here and there a white scale on the trunk; on September 18th all growth had stopped, and October 15th it was a very fair tree, the foliage good in color and very little of it off; isolated scales only were noted.

The experience with this tree illustrates one kind of difficulty met in practical work. On certain varieties and even certain trees the woolly covering is so dense that it is almost impossible to get the wet mixture to the surface of leaves or shoots, and this makes it impossible to get an entirely satisfactory effect.

November 19th, very little foliage off, only one old live scale, while a considerable number of others had been parasitized by the *Aphelinus*.

Tree 39. Fallowater Apple. This tree was in miserable condition in the fall of 1898, and I noted that "it offers every chance for a winter-kill." I did not expect it to survive, and on February 20th, 1899, painted with crude petroleum, intending to kill it if possible, some of the shoots being already dead. To give it a chance, however, it was carefully trimmed late in February, and all the dead wood was cut out.

April 15th, buds were starting evenly. May 7th, it was making a good, healthy growth in spite of the oil, which yet covered everything, and on the 28th it was fully as good as any tree of the series to which it belongs. Plant lice developed rapidly and continuously in spite of their natural enemies throughout June and early July, yet the tree continued to grow. During a brief absence from town a brood of *Datanas* or yellow-necked caterpillars were allowed to develop, and on July 20th they had defoliated three of the branches. Late in August the tree was doing its best and yet growing, but the plant lice and leaf hoppers were sapping its vitality sadly, so I sprayed the lousy shoots with Hammond's tobacco mixture, diluted six times. The day was dull and it drizzled a little later on; used Eclipse atomizer and did not reach the top of the tree. September 5th, found that the application had been quite successful, the mixture had killed everything it touched and the shoots were already showing the results in larger, better-colored and better-developed leaves. September 11th, sprayed from a stepladder with the same mixture as before, so as to hit all the shoots; application made in the morning, rain came in the afternoon and continued quite heavy until late. September 18th, very few plant lice remained, several shoots were yet growing and so continued until early October.

October 15th it was a ragged tree, foliage yet on, of good color, with a few plant lice near the tips beginning to lay eggs.

No scales were found on this tree at any time during the season, and it reached the end of the growing period in vastly better shape than I ever anticipated. Had it not been for the brood of *Datana*, which devoured a large proportion of the foliage, this tree would have been quite as good as any of this series, and it is now free from scales, which was certainly not the case a year ago.

November 19th the tips were yet bright green and very little foliage had dropped.

Tree 40. Lincoln Coreless Pear. All the foliage was off November

10th, 1898. Buds were swelling April 15th, 1899, were opening nicely on the 26th, and on May 7th was in full, rank foliage, some shoots two feet in length. July 8th found quite a number of half-grown scales scattered on the leaves and branches, and growth had stopped. Growth was resumed August 1st, and on the 15th I found a good peppering of scales almost to the tips, larvæ and gray scales being plentiful and tree growing rankly. August 27th lower shoots had stopped growth, tall upper ones yet moving and on September 18th all growth had stopped, the top shoots nearly six feet long. October 15th, it had made an excellent growth and there were numerous scattered scales all over the tree. October 23d I examined this tree very carefully, and to my great surprise I found no larvæ, no recent sets and also that every full-grown scale was dead. I did not examine all the specimens, of course, but from what I did see, I feel convinced that there is very little living scale on the tree.

This tree was scaly when set, was untreated in 1898, and hardly worse at the end of the season than at the beginning. In midsummer of 1899 it was the worst infested of all the trees and the only one on which leaves and young wood were invaded, yet in late October, though no sort of application has been made the scales had died off almost completely. Dozens of large scales were turned, the insects were found to be dead, and from appearances had not bred.

November 19th, the foliage was two-thirds off and scattered scales were seen here and there. Also several groups of collapsed whites.

Tree 41. Elberta Peach. February 20th, 1899, bright, sunny, warm day, much snow on the ground, trimmed the tree carefully, then painted thoroughly with crude petroleum simply to test its effect on the tree, everything being thoroughly soaked. April 22d it had made a nice even start though somewhat behind others of its kind, and on the 26th there were seven blossoms, none of which set a fruit. May 27th, painted with cement and milk, to keep out borers, and up to August 27th the tree grew well, made good long shoots of rank foliage and held its own fully. At the latter date growth had stopped, some leaves on the interior had turned yellow, some had dropped, and on September 18th it had dropped considerable foliage, though it was not noticeably thin.

October 15th it was rated as a good, stocky tree, not high, foliage mostly yellow, much of it off, the balance ready to drop at the least provocation. No scales were found on it at any time during the season. What little was present last fall has been killed by the winter treatment with crude oil.

November 19th, foliage all off, very symmetrically developed, full of fruit buds ; no apparent scale.

Tree 42. Elberta Peach. Started well April 15th, had made a good growth May 7th, plenty of long, vigorous shoots, in which was some tip-borer. To test the effect upon the foliage, drenched May 20th with a mixture of 10 per cent. crude oil, Deming pump, Bordeaux nozzle ; morning bright, cool, a little windy. May 26th, a few leaves had dropped from the lower part of the tree, but there was no other appearance of injury. I think this was due to the fact that the drip from the upper leaves coated some of those below them with a much heavier film than was intended.

May 27th, painted with cement and milk to keep out borers, and growth continued well throughout the season. August 27th, growth had stopped and a few yellow leaves had fallen. October 15th, it was rather a poor sort of tree, taller and not so stocky as No. 41, but otherwise much like it. Foliage turning yellow, some of it already down and some ready to drop.

No scales were found on the tree at any time during the season, and on November 5th the foliage was all down. November 19th on closer scrutiny found a small group of scales on the central trunk.

Tree 43. Kelsey Plum. Foliage about all off November 10th, 1898, full set of buds ; but it looks as if the fruit bark beetle had secured a foothold.

April 15th, tree was starting on one branch only and many small twigs were dead. April 26th the tree was dead, and on May 28th I took it out.

November 7th, set a fine Early Richmond Cherry. The tree is unusually large, good shaped, free from scale and full of blossom buds.

November 19th, painted one branch with all its twigs thoroughly with crude oil, to test the effect upon the blossom buds.

Tree 44. Elberta Peach. Buds started well April 15th, had made a good healthy growth May 7th, a little leaf roller and some plant lice visible. May 27th, painted with cement and milk, to keep out borers. June 11th the tree was growing well, had fairly-colored foliage and some leaves curled by plant lice. June 19th, found one live scale but no larvæ. July 8th, I found some scales on the old shoots of apparently recent origin, and on August 15th some scale was setting in the upper part of the tree. Growth stopped late in September, and on October 15th it was a fair tree only, the foliage about ready to drop and most of it already off. Scales were plentiful all over the tree, which is now the worst on the place. November 5th the foliage was all off. The cement coating on the lower portion of the trunk has kept that section tolerably free, but it is interesting to note that wherever the coating has cracked the scales are set on the exposed parts of the bark. November 19th, there were plenty of recent sets.

Tree 45. Black Tartarian Cherry. This was set as a clean tree October 28th, 1898, replacing a Langford apple. It was started well April 15th, 1899; was just in full leaf May 7th, and on June 11th had made a decent, though not a rank growth. Growth continued until late in August, when the tree was in good condition, and on October 15th it was rather as fair, foliage yet good; no scale.

November 19th, foliage yet all on; no scales seen.

Tree 46. Mountain Rose Peach. Foliage was not all off until the end of November, 1898. Buds were starting well April 15th, 1899; one blossom opened April 26th, the foliage was good, though there were a few borers in the tips on May 7th. Painted with cement and milk May 27th, and on June 11th it was growing elegantly, foliage dense and good. July 8th, found no scale on the new shoots, but some on the old wood, and on August 15th quite a number of white scales were setting on the old growth. Growth had stopped August 27th, and there were quite a number of dropped leaves. October 15th it was rated a good tree, much yellow foliage inside and many dropped leaves; a few scattered scales all over. There was a very little scale in the fall of 1898, and not much more in 1899, the tree having made an entirely satisfactory growth meanwhile.

November 19th, foliage all off, tree very symmetrical, full of fruit buds, a very few scattered scales all over the tree.

Tree 47. Mountain Rose Peach. Foliage about all off November 10th, 1898. Buds just starting April 15th, 1899; one blossom April 26th; good, healthy foliage, with plenty of leaf roller, May 7th. Painted with cement and milk to keep out borers May 27th. Grew well without signs of scale until August 15th, when a few white examples were found on the old wood. Growth had stopped September 1st, and on the 27th fruit buds were setting well and a few recent scale sets were noticed.

October 15th, it was a very good tree, foliage somewhat yellow inside, a very few scattered scales. The breeding here has been very slight indeed, and there seem actually to be fewer scales than in August. November 19th, the foliage was all off and the scale situa-

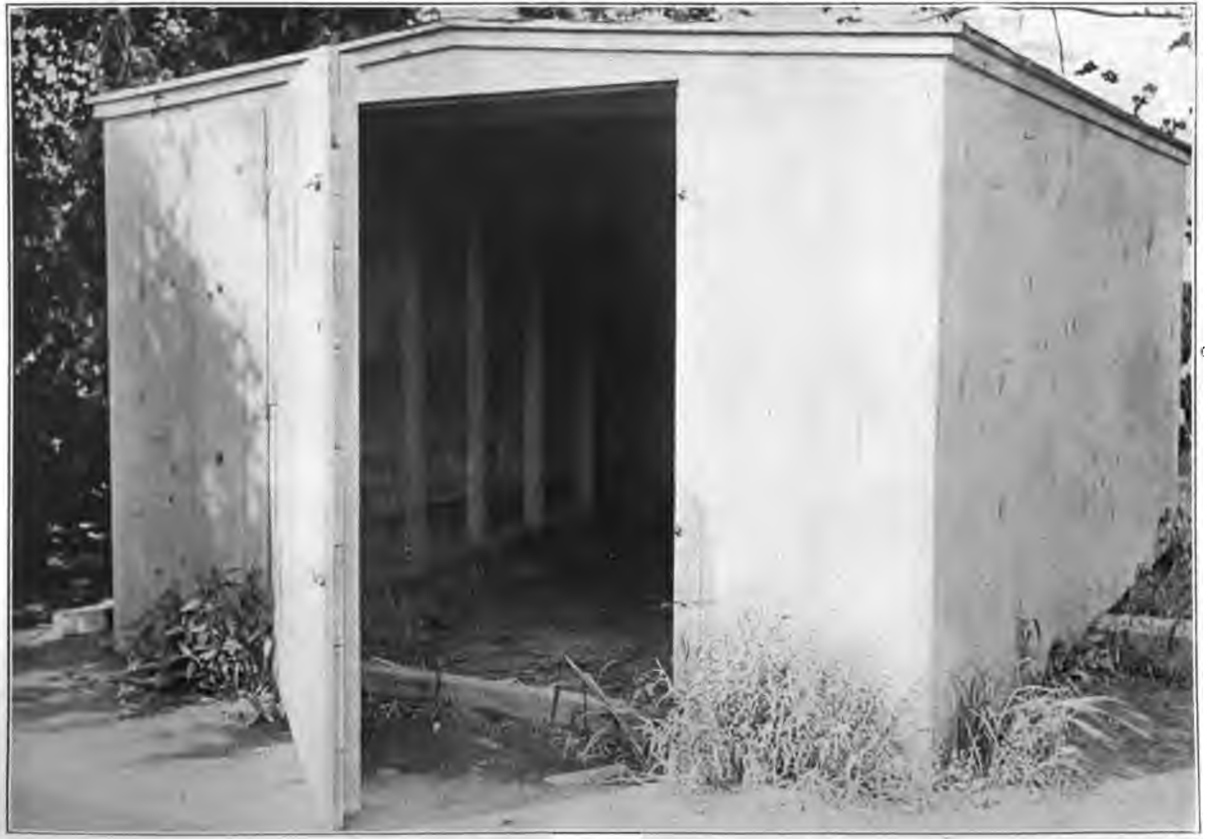

Fig. 37.

Fumigating House on the Lovett Nursery, 16 x 10 x 7 feet.

tion was unchanged, some being found on the old wood and a few on the new.

Tree 48. Triumph Peach. Foliage was not all gone until December, 1898. Buds were starting well April 15th, and on the 26th twelve blossoms opened, from which four fruits set. May 7th, there were good, healthy, long shoots with plenty of leaf roller. Painted with cement and milk May 27th, to keep out borers. Growth continued finely and on July 20th three fruits matured of moderate size, excellent color and very good flavor. August 15th it was much the best tree on the place, and I noted now quite a number of white scales on the upper part of the trunk. Growth had stopped August 27th, some of the shoots being five and six feet in length and the foliage all sound. September 18th there was a good set of fruit buds and plenty of scale.

October 15th this was an excellent tree and the finest on the place, the foliage was almost perfect and scale was scattered all over the tree.

November 19th, all the foliage was off. There was considerable scale on the old wood and quite a bit of it on the new.

Trees 49 and 50 were Rocky Mountain Cherries, which died during the winter and were taken out in April. The places where they had been located were not suitable for trees and they were replaced by rosebushes. Trees 49 and 50, therefore, drop out of the experiment series.

FUMIGATION.

The term fumigation, as employed here, means subjecting trees, shrubs or other plants, or parts of plants, to the action of hydrocyanic acid gas in a closed box, tent or other suitable chamber, for the purpose of destroying such insects as may infest them.

Hydrocyanic acid gas is produced by the action of diluted sulphuric acid upon cyanide of potassium. The acid decomposes the cyanide, forming a very poisonous and penetrating gas, fatal to all animals and insects exposed to it for a sufficiently long time. It is equally fatal to plant life in somewhat stronger doses or on longer exposure. On dormant plants its action is very slow, and they may be safely exposed for considerable periods, two or even three times, at intervals of a few weeks.

The gas is exceptionally effective against scales of the armored varieties, and has been employed in the East chiefly against the pernicious or San José scale. It is in the nursery and in the greenhouse that the method finds its best field in New Jersey, and in the treatment of nursery trees nothing offers greater safeguards against the spread of injurious insects. Woolly plant lice on apple and black Aphids on peach are thoroughly killed off, and the pernicious scale is destroyed unless it is so sheltered that the gas cannot reach it.

So many cases of scales received from nurseries outside of New Jersey have come to my notice during the past year that I am advising all nurserymen to construct a fumigating house or box, and to fumigate everything they buy as a matter of precaution and everything they grow as an advertisement, as well as to destroy those minor pests that are present everywhere and in all nurseries.

The first fumigating box constructed in this State was built at Parry, and is figured in the report for 1897. Several boxes were made soon after on the same model, and on a small scale this answers fairly well. It is, however, altogether inadequate where large amounts of stock are to be handled, and the first house was built by J. T. Lovett, at Little Silver, in 1898. A picture of this house is herewith presented. It was thoroughly well built in every respect and entirely suited for the work to be done. I was present on one occasion when it was operated, and so far as the practical working of the plant is concerned the foreman in charge knew exactly what to do and how to do it.

During the current season, 1899, two houses have been built, one larger, one smaller than that at Little Silver. The smaller is at Moorestown, and is built in the corner of a wagon-house; but with separate double walls, between which is heavy building paper. This house is 10 x 14 x 7 feet, and is as nearly gas-tight as it is possible to get a building.

The largest house is at Hightstown, and is meant to take in a full wagon-load of stock at one time, besides what may be piled behind and at the sides of the wagon. This house is 13 x 20 x 12 feet, and takes a charge containing two pounds of cyanide in two jars. This house is boarded on both sides of the studding, heavy paper being first nailed to the inner sides before the matched boarding was driven in. The house is also painted inside and strips tighten the joints at sills and corners. The doors close tightly and at the bottom are closed by boards from the outside, against which dirt is piled when the house is used.

In the rear of the house a tight box extends all the way across, five feet wide and five feet high, and this is used for small quantities of stock or cuttings, etc., for which it would hardly pay to use the entire space. It may be added that except in the wagon tracks the

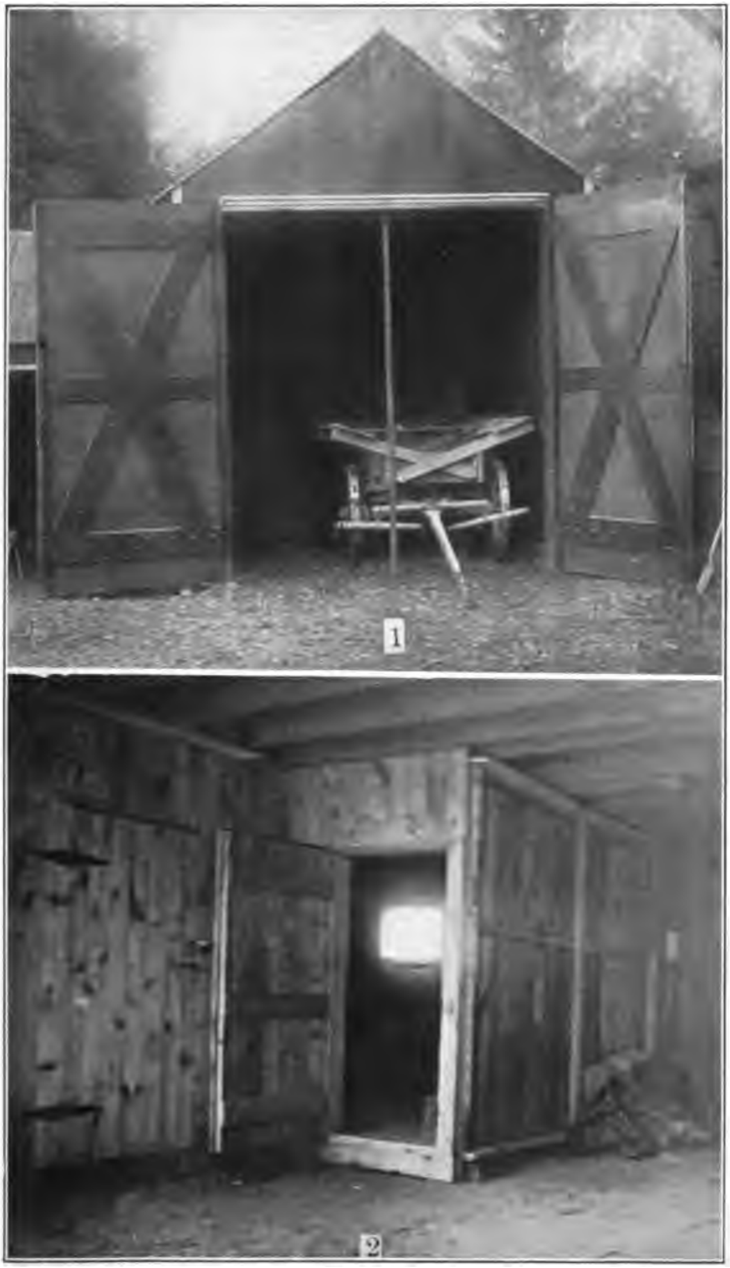

Fig. 38.

(1), Fumigating House on the Nurseries of Jos. H. Black, Son & Co., 13 x 20 x 12 feet; (2), Fumigating-room in Corner of Wagon-house on Nursery of Arthur J. Collins, 10 x 14 x 7 feet.

bottom is grated so as to allow a free diffusion of gas beneath the stock.

Two other houses are to be built and it will be my object to secure their erection on every nursery, that those purchasing from them should have every chance of receiving sound stock if my inspection should overlook a scale or unclean stock be purchased.

Fumigation, though the most effective method we have of destroying scales on nursery stock, cannot be too implicitly relied upon, and like all our methods leaves some chance for the escape of individual specimens even when the work is carefully done. A spun-up leaf, a tying band, a splash of mud, two trees pressed closely together, or a dozen other conceivable happenings may protect a few specimens. So it requires a longer exposure to the gas, earlier in winter, than it does in Maryland or other of the more southern States, because in New Jersey the insect becomes more completely dormant and forms a thicker scale.

In the orchard this fumigating method, effective as it is, has no field in New Jersey, except possibly on young trees, because of the cost. The actual expense of fumigating is small, but the cost of the tents and of the labor and other machinery involved in the treatment is prohibitive. Most of our orchards are small in extent, while our trees often grow very large; State aid, which is given in some cases, is hardly to be hoped for in New Jersey.

It is then primarily with us a nursery method, though every farmer who buys trees largely can do his own fumigating if he has any reason to suspect his stock.

A fumigating house or box has only one essential requirement—it must be tight. Size, shape and material may be anything most convenient, provided it makes a gas-tight receptacle and covers the stock to be treated. It may be built on top of the ground, or a cellar may be utilized, or a cave run into a bank and tightly closed in front. As to shape, square or oblong makes a most convenient form for packing and for getting accurate measurements, but dimensions are not obligatory, nor is form. If placed on the surface, the outside should be banked sill high, and the sill should be half buried inside. The siding should be double, with building paper between, and either inner or outer skin should be good matched board sheathing, not too wide. The ceiling should be like the sides, and the roof above to keep out water may be anything that is deemed desirable. The doors should be made to close tightly against a cloth or rubber cushion to prevent the escape of gas, and they should lock at top and bottom so as to make the joints tight throughout.

A window opposite the door is advisable for ventilation and to secure the rapid escape of the gas, though, if the doors are practically one end of the house, a window is not a necessity. If put in, it should close and open from the outside by a solid shutter that can be shut as tightly as the door. For some reason this gas is more effective against insects and less likely to be harmful to plants in the dark, hence unshaded glass windows are undesirable.

The house or box completed, the next question is as to the amount of material to be used, and this is given on the basis of 100 cubic feet of contents. For fully dormant nursery stock a good formula is for each 100 feet:

Cyanide of potassium, 98 per cent. pure, by weight	1	oz.
Sulphuric acid, sp. gr. 1.83, by measure	1	"
Water, by measure	3	"

A better one, according to Professor W. G. Johnson, of Maryland, who has had great experience with this gas, is:

Cyanide of potassium, 98 per cent. pure, by weight	1	oz.
Sulphuric acid, sp. gr. 1.83, by measure	1½	"
Water, by measure	2¼	"

Other proportions have been given, and, as a matter of fact, it seems that providing there is enough diluted acid to decompose the cyanide completely, the exact proportions are not essential. The important element is the amount of cyanide, and this, as given above, seems to be safe on all dormant stock for a two hours exposure.

Where peach trees are to be exposed for a much longer time or where any stock is to be fumigated all night, one-fourth less of cyanide may be used, with a corresponding reduction of the other materials. The proportion would then be for each 100 cubic feet:

Cyanide of potassium, 98 per cent., by weight	¾	oz.
Sulphuric acid, sp. gr. 1.83, by measure	1	"
Water, by measure	2	"

If cuttings or scions are to be treated, the amount of cyanide may be even less, and Prof. Johnson recommends .16 gram per cubic foot, which reduced to ordinary weights would equal 247 grains per 100 feet, or a little less than three-fifths of an ounce. This would mean acid one ounce and water two ounces. If such small quantities are to be used, the weighing should be done by a druggist or at least on a scales that will weigh accurately the quantities needed. This kind of stock should not be exposed longer than one hour.

Having determined the contents of the house, the amount of cyanide needed and all other necessary details, the cyanide should be broken in small lumps, weighed out and placed into paper bags. Several bags may be prepared at one time and kept in the can of cyanide, which should be stored in a dry place. The house should be loaded with stock, leaving a place for the fumigating jar and a clear path for the operator to get out. The jar should be of glazed earthenware, holding at least double the amount of liquid needed. Place this jar in position with the required amount of water already in it, measure out the acid and pour slowly into the water; the water will heat and come close to the boiling point when all the acid is in. Then drop in the bag of cyanide and get out, closing the door as promptly as possible and making all tight.

Nothing then remains to be done until the stock is to be taken out. Then open doors and windows in such a way as not to receive the outrush of the poisoned atmosphere. Ventilate at least ten minutes before attempting to remove stock.

It should be remembered that the chemicals used and the resulting gas are of the most deadly poisons, and all operations should be conducted with that knowledge in mind. Yet the process is absolutely safe if ordinary care is used. The cyanide should be always kept under lock and key when not in actual use. The sulphuric acid is a horrible corrosive on clothing, and on flesh as well; therefore, pouring should be carefully done. One full breath of the full-strength gas will cause unconsciousness and may cause death. Always pour the acid into the water, never water into acid. The union of the two liquids causes an evolution of heat. If the water is poured into the acid the first few drops will result in a sudden, intense heating that will cause a sputtering and splashing of the acid that may cause injury. Pouring the acid into the water heats the latter more slowly and safely. Dropping the cyanide in a paper bag retards the action just long enough to enable the operator to escape and close the doors.

Instead of filling and then escaping, a small house or box may have an opening at the side or end, into which a long, deep drawer fits closely. The slide for this drawer must be protected inside the box so that it always works freely. Place the jar at the end of the drawer when the box or house is closed, charge as already directed, and, when the bag of cyanide is dropped in, slide the drawer into place, carefully closing the outside opening, that no gas may escape.

The details of the operations described here are given from my own observations as well as from published data. The proportions and statements as to effects are based upon the Californian and Maryland results.

It should be added that the remnants in the jar after fumigating are also poisonous, and should not be emptied close to the roots of a tree or on vegetation that it is not desired to kill. It is best to pour into a hole and cover.

In Circular No. 37, second series from the Division of Entomology, United States Department of Agriculture, directions are given for the fumigation of greenhouses and cold frames. It appears from this that about one-third of an ounce or, more accurately, 155 grains per 100 cubic feet, may be safely employed on a great range of greenhouse plants, but that roses are injured at that strength and carnations cannot be safely exposed to it for more than fifteen minutes.

Double violets will stand half an ounce for a longer time, but single violets are more sensitive. This circular may be obtained by anyone interested on application to the United States Department of Agriculture, and should be referred to for details of treatment, which are important mainly to those growing plants under glass. Greenhouse fumigation is always done at night.

An important point is that the authors of the circulars do not give definite proportions of acid and water. They advise water to equal in bulk the cyanide and pouring in acid until steam is formed.

The matter is an important one for all growers of plants under glass, but it will require a little experiment on their part before they can with certainty treat their chief plants with safety and effect.

SPRAYING.

It would seem as if directions for spraying should hardly be necessary in New Jersey at this time, where spraying pumps of all kinds are in the hands of every up-to-date fruit-grower, and where so many have practiced it for years. But as a matter of fact there are some among those that have had machines for several years who do not understand what really thorough spraying means.

Yet this is of vast importance, and as power machines are coming into use among our large growers a few suggestions on the subject may not be amiss. Spraying from the standpoint of economic

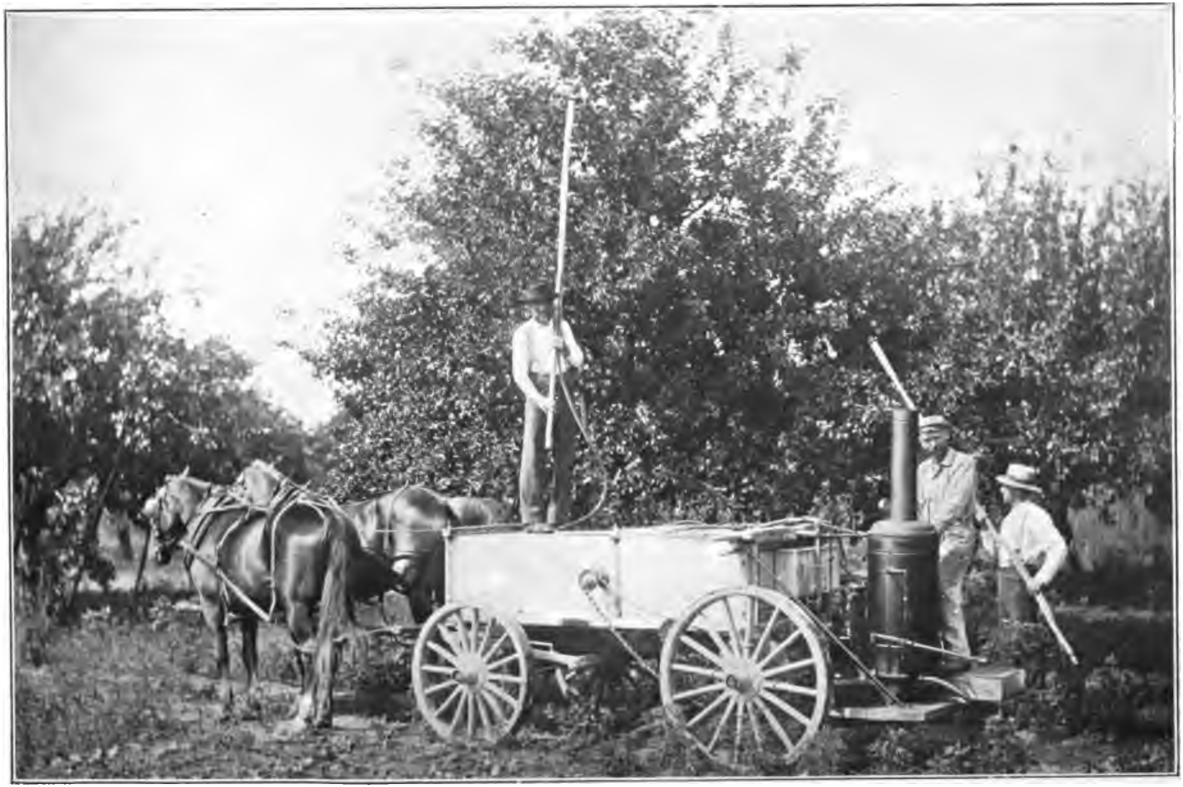

Fig. 39.

Steam Spraying Outfit of John Repp, at Glassboro, N. J.

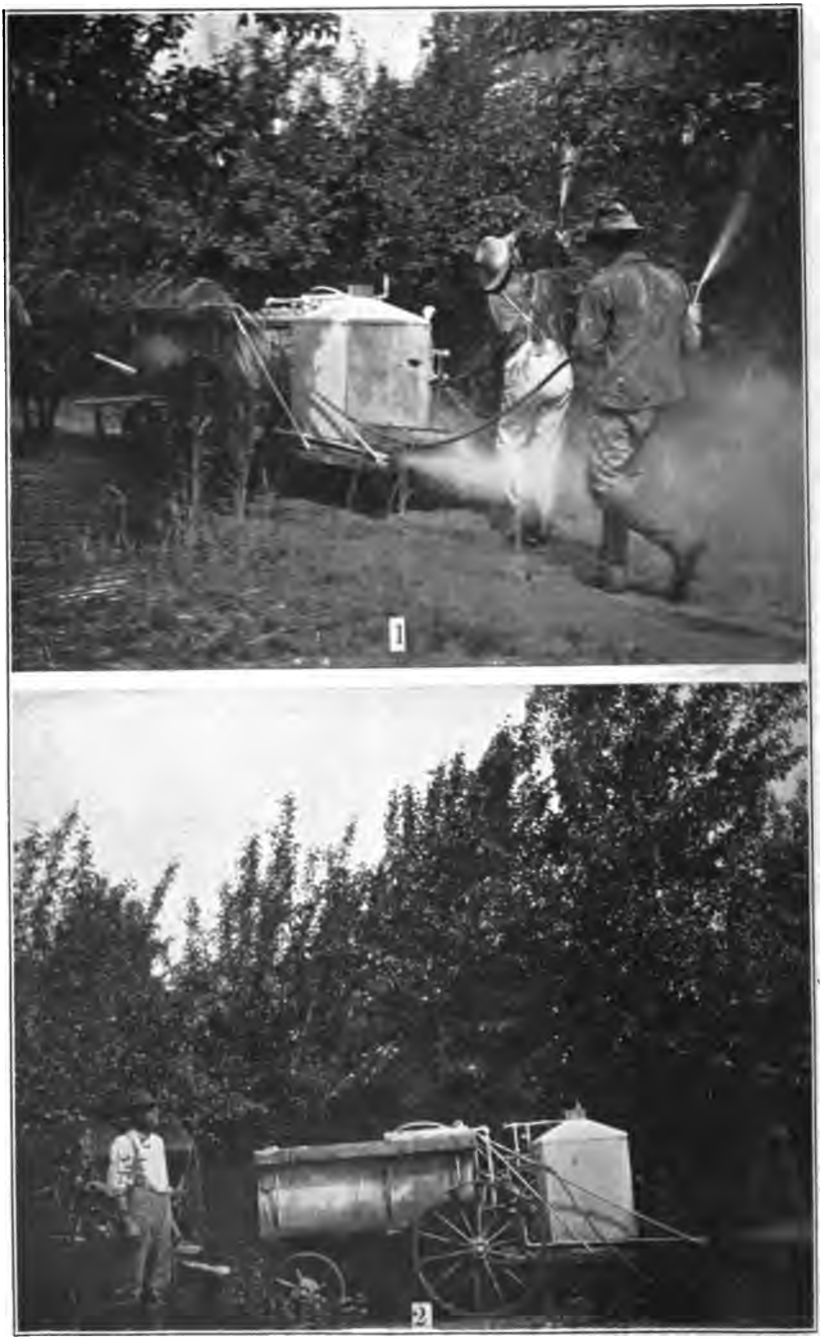

Fig. 40.

Steam Spraying Outfit of Arthur J. Collins, Moorestown, N. J., showing the Machine in Action, (1) and (2) at rest.

entomology means the application of some insecticide in such a manner as to kill by contact or through the stomach the insect against which the poison is used. As a matter of fact this proper application is quite as important as the material itself, because no matter how effective the insecticide, if it be not placed where the insect can get it or come into contact with it, it will be ineffective. Proper application, in other words, is just as important as a proper insecticide.

When a tree is to be sprayed the farmer should know just exactly what he is spraying for, and just exactly what he intends to gain. Spraying with an insecticide "on general principles" is an abomination and likely to do as much harm as good. I am often asked, "Don't you think I had better spray anyway?" and my invariable answer is *no;* never spray until there is a reason for it or an object to be attained, and then work toward it. Spraying is always an expense that is just as well avoided, if possible, and that saving adds just that much to the net profit. No tree or plant, under natural conditions, gets coatings of arsenic, copper, oil or other poisonous mixtures, and while we can now apply most of them without apparent danger to the tree I do not believe any of them actually benefit the plant unless the injury that is prevented overbalances the check to leaf vitality that may be and sometimes is caused.

Therefore I would lay down as a cardinal rule in making insecticide applications: never spray until there is a necessity for it, and then know exactly what result you expect to obtain and how it is to be attained.

A second rule of equal importance is, direct the insecticide to the point where it is to become effective. This seems so self-evident a proposition as scarce to require statement; yet I have seen men spraying to kill the pernicious scale in summer and directing the nozzle to the outside only, so that the outer leaves were dripping, while the twigs and branches, where the scale was clustered, received only the material that came through openings in the foliage, the liquid that ran down the twigs and stems and the drip from above. The result is bound to be ineffective and is promptly charged to the material used, not to the imperfect work. All the mixture applied on the outside leaf-surface was wasted and the application should have been made altogether from the inside of the tree.

This kind of spraying is very apt to be done with geared machines and power pumps that are kept going as the cart or wagon moves. When the application is made from all sides, this sort of work is often very effective against the codling moth, for the fruit to be protected is very largely on the outside of the tree.

For the pernicious scale, or in fact for any scale, this method will not do at all. Against these insects we use contact poisons, and a contact poison is one that kills when it touches an insect. Now it makes absolutely no difference how deadly such a poison is; if it does not hit the insect aimed at it is ineffective. A leaden bullet discharged from an old-fashioned blunderbuss is deadly if it hits the person aimed at, but the entire load of a modern Winchester repeating rifle is harmless if it is aimed too high, too low or too much to either side.

In other words, the fight against certain species of insects has resolved itself, practically into the mechanical problem of placing a material which we know to be effective into the proper position to enable it to exercise its power. On this point I wish to be emphatic, because the work of the entomologist is done when the proper remedial measures are pointed out, and when it has been shown that they can be applied practically.

If the first and second rules have been carefully attended to, the third, which is, *do the work thoroughly*, comes into operation. This is really a supplement to the second, for, when the spray is properly directed at the points where the insects are to be found, *all* those points should be systematically treated. In the work done for me during the summer, I instructed the men to take in order, the trunk, the main branches with their separate branches and twigs each in succession, and I saw that they understood just what I wanted and did it. It took a little longer—not much after the men were used to it—but it left few missed points, and the mixture was exactly where it could be most effective.

Important, though subordinate to the considerations already mentioned, is the matter of machinery. Any old pump that gives a pressure upon a hose will answer, and any nozzle through which water can be forced may be made to serve; but there is no greater source of waste than a hard-working pump, which tires the men working it, nor a more unsatisfactory contrivance than a nozzle which throws an irregular or too coarse or too fine a spray.

An immense amount of time is lost by inadequate outfits. A man undertakes to do the work of an orchard with a machine intended for garden use and spends as much time hauling water as he does in the actual work of spraying. This makes the work more expensive than need be, and the cost of the time thus used would in one season pay for a machine of wider range.

Two orchardists now, at least, in our State have power pumps, and others will have them in the course of the next season. Both are steam pumps of simple type, using oil as fuel, and both are capable of furnishing satisfactory pressure with very little attention. A pump of this kind requires a team to draw and three men to work it—one to tend to horses and engine, the others to direct the nozzles. A great deal of work can be done with such an outfit, especially if the tank is of large capacity.

There are now, however, a sufficient number of good hand pumps that will, with a moderate muscular effort, give a good pressure on two lines of hose, and these, if mounted in a tank or hogshead on a platform wagon, are capable of doing a great deal of work in one day. A very good arrangement is a tripod pump with a long suction hose which can be thrown into a barrel; this admits several barrels on one wagon, which can be drawn from in succession, or admits of replacing an emptied barrel by a full one from a platform upon which it was prepared while the other was being emptied.

The matter of emulsion pumps is becoming important. I have had two types in use during the season. Three of them were made by the Deming Company, of Salem, Ohio, and of these the knapsack and bucket pumps proved entirely satisfactory. The barrel pump did not work as well, and the proportion of oil and water was not constant. Part of this seems to be due to a separation of oil and water in the pump when work is stopped in moving from tree to tree or for other reasons. At all events several of this type have failed to approve themselves.

The Gould Kerowater has been used throughout the season in my orchard experiment work, and with uniform satisfaction. The principle upon which this machine works is much better than that of the other machine and the work is more uniform and reliable. The one danger with this machine is that either oil or water may be allowed to run out unnoticed. It is but fair to say that one complaint has been recently received against this pump also, and it may be that there is an element of weakness in the construction that I have not yet discovered.

I am inclined to urge very strongly upon farmers that when purchasing pumps they purchase those of large capacity, capable of doing more rather than less work than is needed.

Among nozzles for orchard work none have approved themselves better than the Vermorel. Fan-shaped sprays are excellent when it is a matter of covering the foliage from the outside, or even on the trunks and large branches, but inside the tree the fan is much inferior in covering power to the umbrella, though it reaches further. An almost ideal spray is made by a group of three Vermorel nozzles, and, at the end of a ten-foot gas-pipe or bamboo stick, it makes an effective instrument for soaking the interior of a tree so as to get at all the twigs, shoots and branches. A gas-pipe extension is lighter and less clumsy than a bamboo carrying a hose attached to it, and it has the further advantage that a shut-off can be placed at the lower end, by means of which the discharge can be stopped at the will of the operator.

To sum up, the proper application of the insecticide is quite as important as the insecticide itself, and the latter, however good in itself, is utterly ineffective without the former. Simply wetting a tree through a nozzle is not spraying, and proper spraying requires good judgment, an accurate knowledge of what is to be accomplished and a determination to accomplish the object aimed at. The proper outfit is here assumed.

Another factor that is not mentioned is the matter of the time at which the application is made. The importance of this has been elsewhere urged, and here only the method of making the application is spoken of.

THE PERNICIOUS OR SAN JOSE SCALE.

Aspidiotus perniciosus Comst.

The early summer season of 1899 was unusually favorable for the development of this insect. The long dry spell in May and June, with a rather uniformly high temperature, seemed to be just what was needed to bring the hibernating forms to maturity and at the usual time, *i. e.*, June 10th and 12th, breeding began with unusual vigor. In the orchard in which most of my observations were made and my experiments were carried on, almost incredible swarms of larvæ appeared; but this lasted little more than ten days, or at the outside, two weeks, and then the numbers diminished until, in early July, few moving forms were seen. Late in July the second brood made its appearance, and in the first days of August the yellow swarms were everywhere apparent, lasting throughout the month and almost merging into the mid-September or third brood, which, this year, was not nearly so plentiful as the first or second. But breeding was

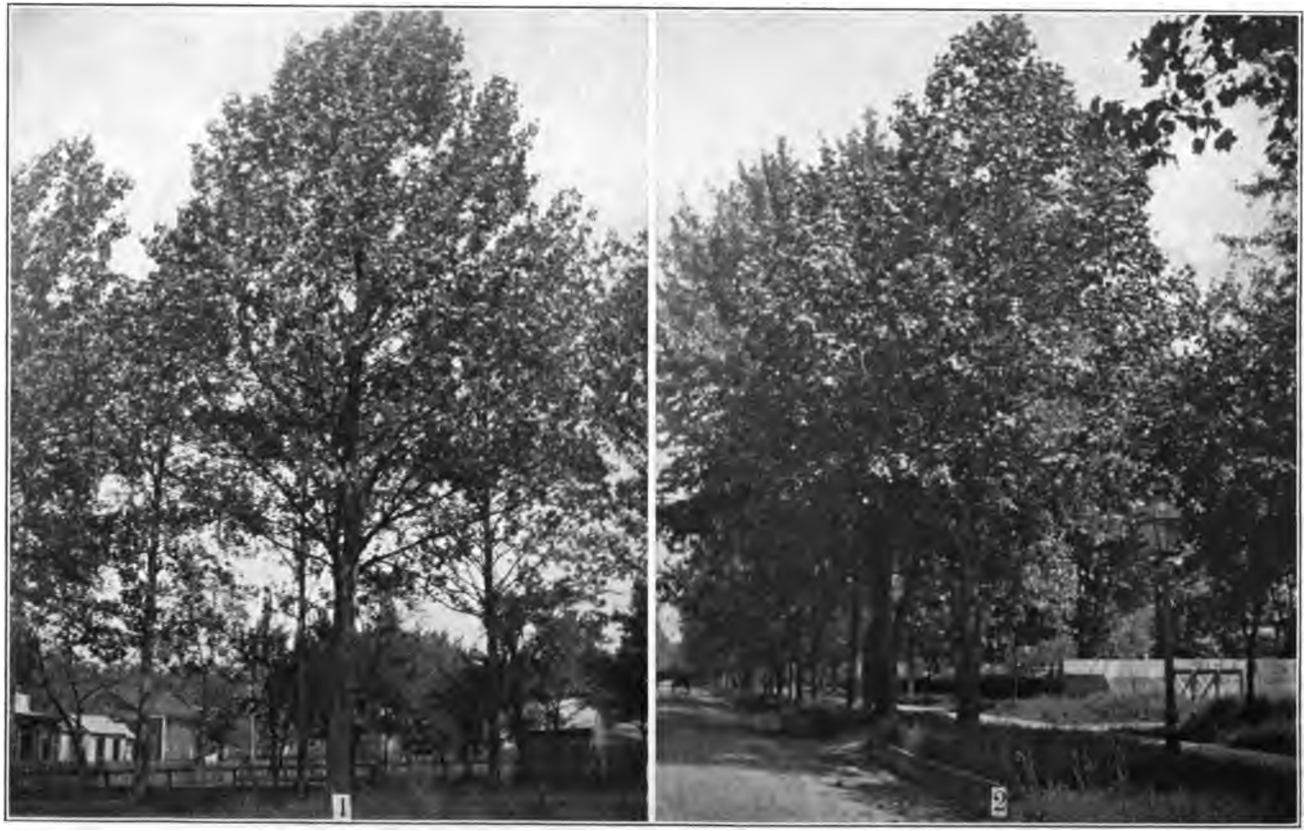

Fig. 41.

(1), Tulip Tree at Vineland, Sprayed with Crude Petroleum March 80th ; (2), Tulip and Maple Trees Sprayed with Kerosene, Undiluted, March 80th.
Photos were made June [illegible]

now uninterrupted, the heaviest swarm of this brood coming early in October. Late in the latter month the fourth brood began and a few larvæ appeared, becoming gradually less, until in early November few moving examples were seen, though many of the full-grown females had several young beneath the scales with them. The observations of the present season have strengthened the belief formed in previous years that the hibernating individuals are those of the late third brood, and this accords well with the fact that none begin reproducing in spring until June 10th, and that all begin at about the same time. The larvæ that set in late October or early November almost always collapse in the white stage, while those that begin breeding at that time are found dead during the winter. We have in New Jersey three full and a very partial fourth brood, few if any of the latter surviving the winter. One thing may be considered as settled after the past winter, and that is, that the scales will pass safely through a temperature low enough to kill all the fruit buds on the trees infested by them.

Distribution in New Jersey.

As has been indicated in the "General Review," this insect is now known to occur in every county of the State: sometimes pretty well distributed, sometimes very local and in small numbers. A number of such small infestations have been discovered and cleaned out. Most of what has been newly discovered has come in recently, mostly from other States, and several times cases have been located by following the track of a tree agent.

This individual has been perniciously active in many of our towns and small cities, selling hedges, trees and shrubs for ornament or fruit, and throwing in scales for good measure without any extra charge. Currants infested by this insect have been sent in from New York in great quantities, apple trees come largely from Pennsylvania, plums "from the South somewhere," hedge plants and some ornamentals from Long Island. I found, in previous years, that a string of Delaware river towns was pretty well infested; I find now a somewhat similar sort of infestation extending from Jersey City to Paterson, to Montclair, through the Oranges, to Plainfield and to parts of Bergen county. Hedges are largely infested and currants almost universally. These things die out, are removed, and the infestation ends. Thus far I have not found that any usual shade tree has become infested to any noticeable extent.

I reported in previous years that in some cases prompt treatment had eradicated the scales and most of these localities have been visited this past season, confirming my previous conclusions.

Turning from the newer districts which are mostly in the northern and extreme southern portions of the State, to the older points of infestation, it may be said that the scale has just about held its own in territory or has increased it somewhat, and that it has gained and lost, locally, in the intensity of its attack. The loss of a few trees has sharpened the attention of the fruit-growers, and several orchards, chiefly peach, that seemed doomed last year, have been rescued by a free use of soap, kerosene and crude oil. Some of these bore heavily this year and paid for the expense of treatment several times over.

Treatments Employed.

It has been already indicated that whale-oil soap was used in great quantity during the winter of 1898 and 1899, and this was the material most generally used on peach. The time of application was generally March or early April.

In some districts kerosene was generally used with good success and in a few localities crude petroleum was used experimentally, with excellent effect.

Kerosene was used as a rule on apple and pear, though not infrequently on peach also, and only in the rarest cases was any injury caused on the treated trees. A sample record is as follows, concerning trees treated in early April, 1898, and reported upon May 1st, 1899 : "Would say that I treated every tree that was infested with scale by painting them from top to bottom with coal oil, pure and simple. I put on plenty of it and the result is that at this time I cannot find a vestige of the scale in my orchard : surely, none on the trees so treated. Some were pears and some were apples ; they are all now looking well and healthy, and full of bloom. I took the coal oil in a can and used an ordinary paint brush to spread it. My trees, of course, are small and easily got at by means of a stout ladder."

The crude oil experiments are recorded in order in Bulletin No. 138 of the Experiment Station, which should be consulted in this connection. Some of them are incidentally repeated here in the records of the experiment orchard, and others of them will be stated in the record of the work done during the season in the Riverton orchard.

Spraying Experiments.

To test the effect of summer applications on the orchard as well as the pernicious scales, arrangement was made to treat a certain section of a badly-infested pear orchard in accordance with my directions and at the expense of the Experiment Station. The outfit

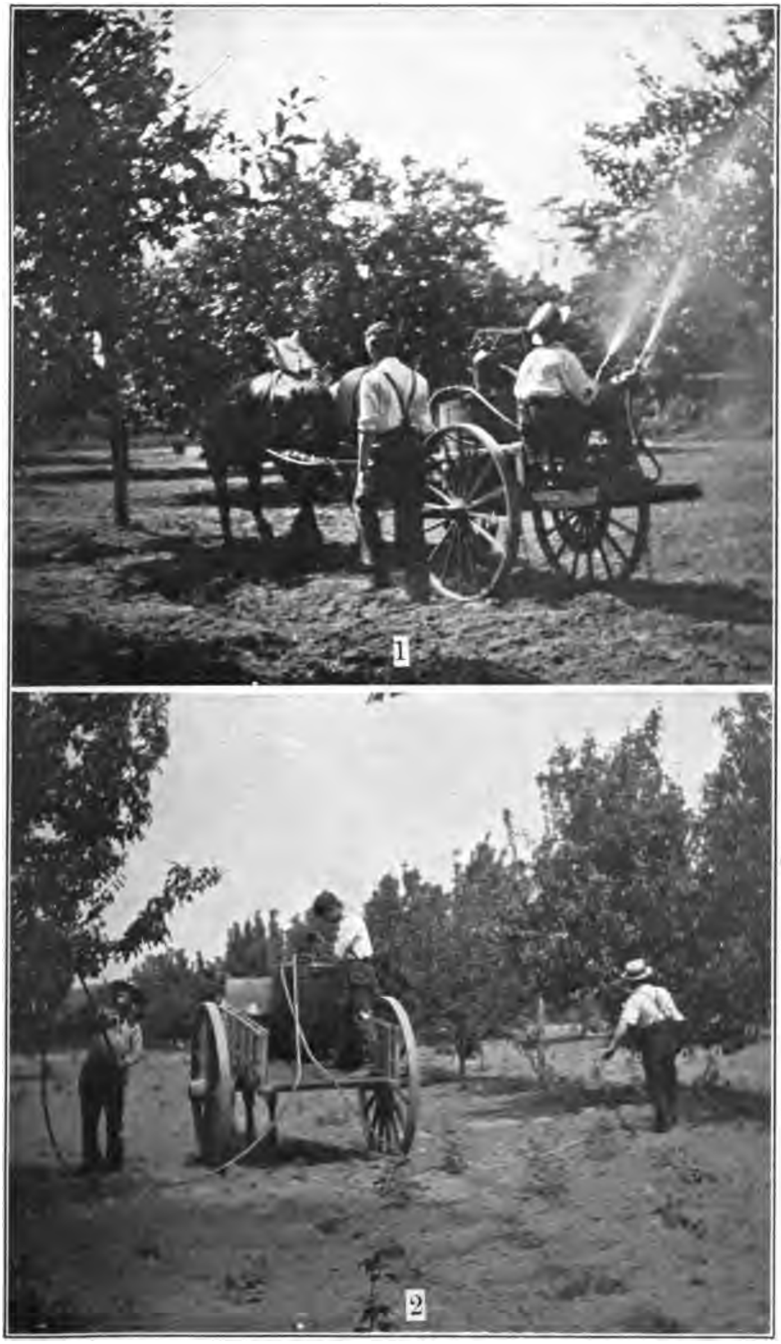

Fig. 42.

(1), Spraying Apple Trees with a Geared Machine; (2), the "Kerowater" outfit as used in my Riverton Experiment. From a photo. made June 15th, 1899.

consisted of a Gould Kerowater pump mounted on a barrel and carried in a two-wheeled cart drawn by a horse. There were two lines of hose, each twenty feet in length and two ten-foot gas-pipes with shut-off at bottom, tipped by a Vermorel triplet; all made by the Goulds Manufacturing Company. This outfit gave excellent satisfaction, and the only fault to be found with it was that refilling was too often necessary. The experiments were not carried to the end determined upon because the owner planted a part of the experiment section in sweet corn between the rows, which made the intended September application impossible. Its effect was further interfered with by the non-arrival of a barrel of kerosene on schedule time, and in a way this illustrates the character of the matters that interfere with the thorough carrying out of a course of treatment.

Before determining on the experiments, the orchard was examined as a whole on May 4th and 8th. The upper section had been badly infested for five years, and this was largely Dwarf Duchesse with standards of other varieties alternating in the rows. The central section was of apples chiefly, the trees increasing in size and age toward the town, and this was of more recent infestation, though now becoming bad on some trees. The lowest section is almost worse than the upper, because the scale had not been noticed here until some of the trees were so badly injured that they were cut out as the easiest way of dealing with them.

A large part of this territory was sprayed in March, with a 30 per cent. mixture of crude petroleum and water, but irregularly. A Deming pump had been used and the proportions varied from clear oil to water. Several days were needed to complete the work, and spraying was always with the wind, sometimes one side, sometimes the other; hence the covering was very incomplete and nothing like a thorough bit of work was done. No trace of harm was seen on trees of any kind, either of the varieties already mentioned or on the peaches which were set out in the intervals of the rows in one section.

It was determined to reserve the upper section for the experiment, and to use 15 per cent. crude petroleum in a mechanical mixture with water. Preliminary tests developed this as an unsafe combination on green foliage and kerosene was substituted instead, on the majority of the trees.

Spraying was begun June 15th, at which time the scale was breeding in immense quantities—more numerous indeed than I had ever seen them before. The hot, dry weather of the past weeks had been favorable to the development of larvæ, which were swarming in almost incredible numbers. A very curious feature was noted on the trees that were sprayed on one side only with crude petroleum during the winter. No larvæ were developing on the sprayed side; but on the other everything was a crawling mass. Yet there seemed to be an attraction in the brown, greasy surface, and thousands were making their way on to it, only to die in swarms. On some trees they were crowded so densely as to hide the surface, and all were dying and discolored. I did not see anywhere a well-sprayed surface upon which the larvæ had succeeded in obtaining a hold, while on the unsprayed sections everything was crowded with recently-set scales.

Work was begun on row 4, on which only the small Dwarf Duchesse trees were sprayed and the Keiffers were left untouched. Crude oil was used in this tank, and 15 per cent. was the proportion employed. On row 5 and all the other sprayed rows all the trees were covered. One tank of crude oil only was used, covering rows 4 and 5 from both sides. For the balance of the experiment kerosene was used at the same rate, *i. e.*, 15 per cent. The application was very thorough, the trunks and branches being separately sprayed, and the effort being to get the tree wet until it dripped. The work was done as thoroughly as it could be, yet on the larger trees I have no doubt there were missed surfaces enough, and it seemed almost impossible to hit everything as satisfactorily as was desirable.

It was at first intended to spray each tree completely before leaving it, but this proved unsatisfactory because of the width of the rows and other practical difficulties; therefore, after two rows had been completely sprayed with the 15 per cent. crude oil a change was made, and in driving between the rows that half of the tree next the cart only was thoroughly treated. Driving between the next rows the half-sprayed trees were completed and half of the further row was taken. In this way each tree was hit from two sides and practically from all, receiving a drenching dose. In the treated sections were 35 rows of about 30 trees each; some more, some less, according as there were missing dwarfs and standards had replaced them at greater distances apart—in all, a little over 1,000 trees.

The barrel holds about 40 gallons, the oil reservoir about 5, and the 45 gallons sprayed thoroughly one row, or one-half of two rows, making an average of six quarts per tree, large and small. By the method adopted, each tree being practically twice sprayed, about one-half more was used than was really necessary, but the result was good, and after the men had completed a tree I was able in rare instances only to detect a dry spot. To spray a row thoroughly required a trifle less than half an hour; to refill the tank and get back meant as much more, and 45 gallons an hour was the practical limit

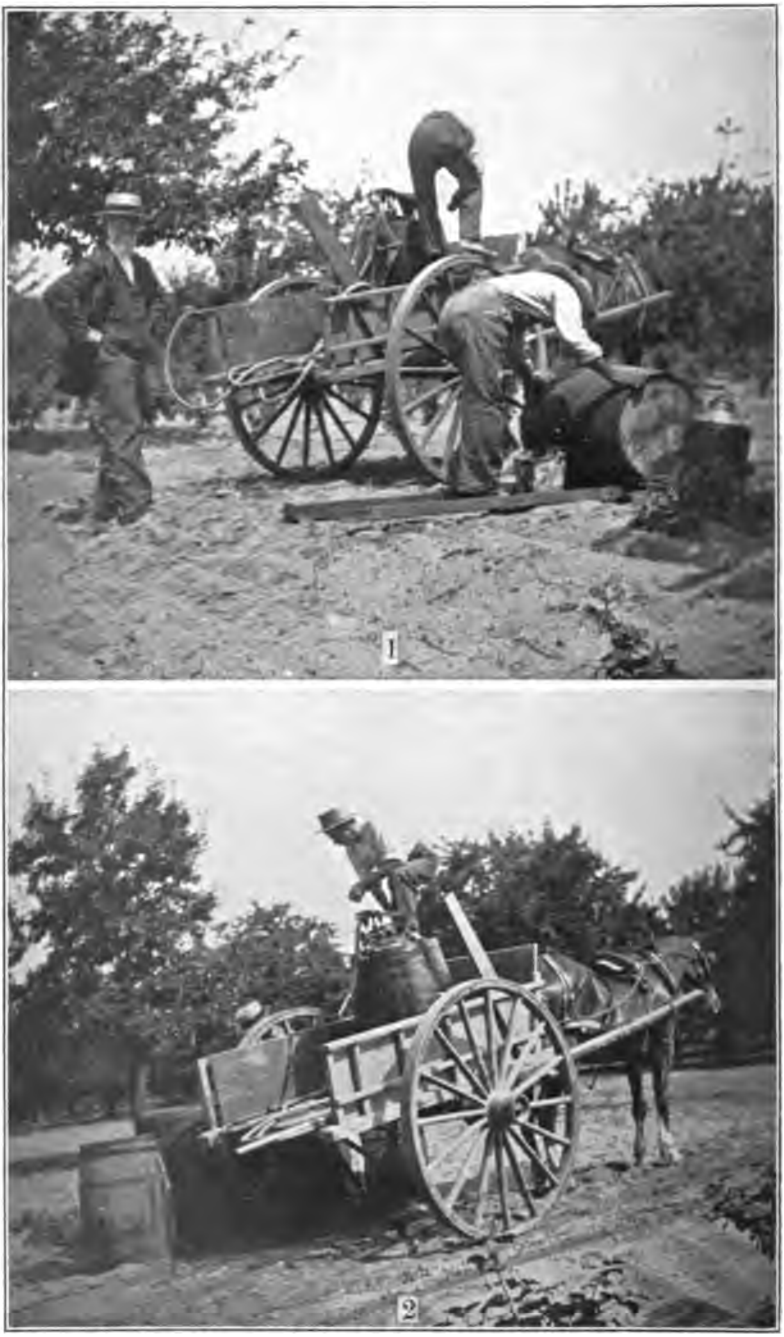

Fig. 43.

(1), Refilling Kerosene Tank in the Orchard; (2), Water Supply Station, showing the "Kerowater" outfit and how it was mounted.

on this first day, more than half the time being used in renewing the insecticide supply. The wages of the force employed averaged $1.25, so that labor cost $3.75. Ten rows, or three hundred trees, were completed, and, adding $2.25 for the horse and the kerosene, each tree cost two cents.

June 16th, the work continued, somewhat better progress being made with better organization. A barrel of kerosene was now in the orchard, and several barrels of water had been carted out, so that less time was lost in refilling.

On this day spraying was also started in an orchard near Cinnaminson, a Deming pump being used, with two lines of hose, each ending in a single Vermorel nozzle. This was more economical in material, but wasteful of time, though as the trees, apple and pear, had but a small top, this was not so serious a matter.

Spraying was continued in the Riverton orchard on the 16th, and, as by this time the men were doing even work and knew exactly what was required, I did not get down again on the 17th, expecting that the work would be completed on the 18th.

June 21st, I was at the orchard again and found the last rows being sprayed. It seems that the kerosene that was ordered and expected on the 16th did not arrive until the 20th, hence spraying was suspended on the morning of the 17th and recommenced on the morning of the 20th. Nearly all day of the 20th and part of the morning of the 21st were used in completing the work.

Examined the trees first treated with the crude oil rather carefully and found foliage here and there spotted, and a considerable number of dropped leaves. There was no check to growth, however, nor injury to tips or fruit or signs of harm to the shoots. The application seems to have been fairly effective, because very little was seen of moving larvæ or white scales. All the swarms of larvæ on the tree at the time the spraying was made seem to have been killed, and so were also the white scales. It is obvious, however, that a large percentage at least of old scales escaped and are yet bringing forth young. This was not unexpected, because kerosene so much diluted has proved unable to penetrate through the scaly covering of the insect. It is only when such a scale is uplifted to permit of the exit of the larvæ that there is the least chance of the diluted mixtures getting at the insect underneath. That it did this, in some instances, I found reason to believe, but as already stated, a very fair percentage remains in condition to continue reproduction.

On the rows treated with 15 per cent. kerosene there was much less appearance of injury. Here and there a tree showed signs of some "burning" in the foliage, and from an occasional tree a few leaves had dropped. This was in the rows treated on the 15th and 16th, and not a trace of the kerosene remained on the trees. So far as effectiveness is concerned there was nothing to choose between kerosene and crude oil, and, under the circumstances, the kerosene was the more satisfactory of the two.

On the part sprayed on the 20th, the result is not nearly so satisfactory. The delay in making the application permitted quite a number of specimens to reach the second, or gray stage. This gray stage of the scale is not readily penetrated by weak mixtures, and a large proportion seemed to bid fair to reach maturity. On the other hand, more of the breeders were killed here and this may offset the disadvantage suffered.

Breeding was progressing on untreated trees at a terrific rate, and I never saw larvæ so fearfully abundant; even old trees beginning to show the effects of the drain in some instances. I noticed again, on the half-sprayed trees, the curious fondness manifested by the larvæ for the brown, oil-covered surfaces. They swarmed to them in thousands, fixed, became round in form, turned black or brown and collapsed, very few of them ever reaching even the white stage. On one variety of apples a kind of sun scald was noted on one side of the trees very heavily treated with oil during the winter; but this was only skin deep, and took the form of a blistering, beneath which the bark tissue was normally green and healthy in appearance.

July 27th, again went over the sprayed district rather carefully to note effects on both trees and insects. Found that where the 15 per cent. crude oil had been applied, the Dwarf Duchesse had suffered considerable injury; quite a large percentage of the leaves had dropped and the rest of the foliage did not look up to the standard. None of the other varieties showed any particular signs of harm, and even on the Duchesse the development of the fruit was not interfered with. Where the 15 per cent. kerosene had been applied no injury of any kind was noticeable on any variety. It was possible to see then that, though the application had been very effective, it had been by no means complete. On some trees scarcely any breeding scales were noticeable, but on most of them some nearly full-grown specimens were found near the tips of the short roots. These seemed to be the examples that had passed from the white to the gray stage at the time the spraying was done. There were no moving larvæ and no very recent sets; from all appearances breeding must have ceased at least ten days ago, while none of the new brood had yet emerged, though about ready to do so. Altogether, despite the heavy early swarms, this part of the orchard was in decidedly better condition than at the same time last year. It was noticeable that on the heavily-loaded branches of the Duchesse the tendency was to break the tree, and in many cases the heavy pears were breaking the fruit spurs upon which they were set. This was evidently due to the injury caused by the scale in the past years, the spurs having been dwarfed and partly killed by the continued sapping of the juices.

After examining the whole territory it was decided to spray a second time August 4th or 5th with 10 per cent. kerosene one day only, treating the worst-infested section and noting the differences between the results of one and two sprayings.

Spraying operations had been carried on in an adjacent orchard with the Goulds machine after June 21st, and the difference between a timely and a delayed spraying was here very decidedly marked. A very large set had been made before the insecticide was applied, some scales having passed out of the gray into the black stage, and none of these were in the least harmed. The hibernating forms were probably almost all killed and breeding was checked, but there had been nearly ten days of unrestricted multiplication and in some cases more. Among the sprayed trees were quite a number of peach one year out, and these were almost all injured in some way; usually the trees were partly defoliated, sometimes wholly so, and a few were killed outright. It is obvious that a drenching with even a 15 per cent. kerosene mixture will not do for young peaches, especially where the mixture had a ready chance to run down the trunk into the soil. The land here is very light and there was nothing to prevent the insecticide from getting down the trunk directly to the crown and roots. The character of the killing, complete from the root up, seemed to indicate this happening. That much stronger mixtures may be safely used when the application is carefully made has been abundantly proved, yet this experience is a useful one, since it indicates that even a safe mixture may be at times unsafe. The trees that were not actually killed suffered no material harm.

August 4th the second spraying was made on twelve rows in what has been in times past the worst part of the orchard, about 350 trees being treated. The outfit previously described was used and gave perfect satisfaction, greater tank capacity being the only addition that could be reasonably required. At this time the instructions were to spray not only the inside of the tree as in the first application, but the outside as well, to hit any larvæ or recent sets that might be on the fruit. Now, the man who did the pumping also regulated the shut-off for the two lines of hose at the tank. If one man had a small tree and was through with it before his companion on the other side, the entire supply was turned into the single hose. In this way material was economized and the labor of pumping reduced to a minimum. Altogether the work was done in an eminently satisfactory way.

Looking over the orchard at large, even casually, the sprayed district was at once recognizable. There was not only much less infestation on the trees, but there was very little specking of the fruit in any case, while it was often entirely clear. There was probably not a single tree that had been entirely cleared by the first application ; but there were many on which there was a full set of fruit entirely free from scale.

On this same 4th day of August I revisited an orchard about three miles from Riverton which was infested four years ago, and on which some whale-oil soap had been used on some trees during the winter of 1898-'99. The situation was scarcely different now from what it was four years ago ; there is perhaps a more general infestation ; but even in the worst case there has been no interference with either the growth or the productiveness of the trees. Several applications have been made in a hap-hazard sort of way ; potash, whale-oil soap and kerosene have all been used, but never systematically ; yet the trees were heavily set, almost overloaded, indeed, and only in a few instances were any scales on the fruit, even though the second brood was now in full swing. The trees are Keiffer pear, and this may be one reason why the scale has not been more abundant or destructive.

The Riverton orchard was visited several times during August and each time the differences between sprayed and unsprayed and sprayed once or twice became more strongly emphasized. On the unsprayed sections many fruits were absolutely unsalable and a large percentage was badly infested. Where sprayed once, I saw no unsalable fruit and none that was badly infested, though some became specked early in September. In the district twice sprayed, I believe that a number of trees were completely cleaned, while on all the scale was reduced to a very small amount. Specked fruit was scarce and none was badly infested. As to injury to the tree, none whatever was caused. So far as I could find, there had not been even a leaf dropped on this account. As to its effect on the scales, the 10 per cent. mixture seems to be quite as satisfactory as that containing 15 per cent.

It was intended to spray a third time, in the early part of September, half of the trees that were twice sprayed ; not so much to kill the small remnant of scale, though this was a desirable object, as to

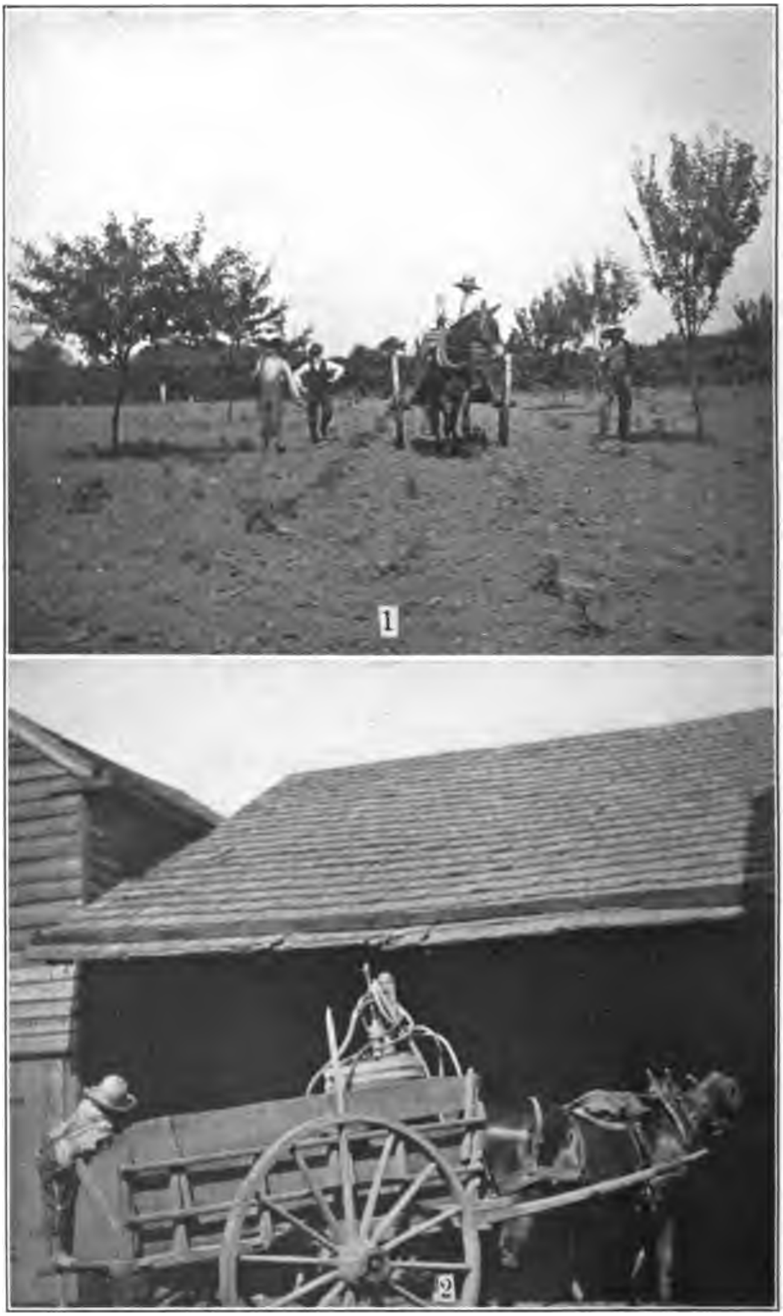

Fig. 44.

(1), The Deming Emulsion Pump at work near Cinnaminson; (2), Deming Emulsion Pump as mounted, ready to take the field. Photos. made June 16th, 1899.

note the effect of several successive kerosene applications on the trees. Unfortunately late sweet corn had been planted between the rows in the orchard, and, at the time when the spraying should have been done, the ground was covered with cornstalks, so that it was impossible to drive in with a cart. The experiment was abandoned ; incomplete, yet very satisfactory so far as it went, and carried far enough to give a safe basis for judgment as to the effects of this sort of treatment. The reason for the termination of the experiment illustrates a class. Many farmers, in their desire to make the most of their land, burden the orchard with crops between the rows, especially while the trees are small, and often have rows of small fruits between the rows of trees. Now, there can be no possible objection to this course when trees and other crops are both fed ; but the trees must be left to look after themselves, so far as insects and diseases are concerned.

October 18th, I found the sprayed sections yet in good shape ; all the fruit off, the buds maturing nicely. Very little scale where the trees were twice sprayed, quite a sprinkling where only a single application had been made. A few trees seem to have been completely freed, and all are in very much better condition than they were a year ago. The crude oil trees were not distinguishable at this time from those sprayed with kerosene.

Lessons of the Season.

Considering the experiments just recorded, those recorded for the experiment orchard, those recorded in Bulletin No. 138 with crude petroleum, and the observations made during the season in numerous orchards at widely-separated points in the State, the outlook is not a discouraging one. Care in purchasing stock will, to a great extent, prevent the introduction of this pernicious scale into districts yet free from it. Its natural spread is usually slow, and it does not easily overleap barriers like a stretch of cultivated land or a woodland.

An orchard not absolutely adjoining one that is infested may remain free for a series of years even in an infested district, and there are many miles of territory in our State that will remain free for ten years to come and longer unless the insect is brought in on scaly nursery stock. It is for this reason that I urge upon our fruit-growers the greatest care as to the source from which they obtain their stock, and it is for this reason that I insist, so far as I have power to do so, upon having every parcel of stock that is shipped into New Jersey accompanied by a certificate, and this certificate should be read by the purchaser to make certain that it is really a declaration that an inspection has been made and not a substitute calculated merely to pass muster at the freight or express office.

It is for this reason also that I am advising the erection of fumigating houses on nurseries everywhere; it is an additional precaution and it may retard the spread of the insect a greater period of time. Each year increases our knowledge of how to deal with the species, and each year adds to the effect of those natural conditions that will inevitably tend to reduce its destructiveness. It is perhaps impossible to predict just how this check will act, and it may, and probably will, act in mitigation only; but just as our trees have accustomed themselves to the drain by dozens of other species, so will they also learn to adapt themselves to a moderate drain by this species also.

We may reasonably expect, also, that our methods of dealing with the insect will improve with each year, and so those that can put off the day of infestation will find themselves better prepared for the insects when it does come.

It is probably as safe for a New Jersey farmer to buy his stock from our own nurseries as to purchase from those of other States, making certain, however, that the nurseries have been inspected and found to be free. I do not mean to assert that I am able to discover every slight infestation in a large body of trees, hence even inspected stock may not be absolutely safe; but the risk is exactly the same from other States; and if the purchasers demand, also, that the stock be fumigated as a matter of additional precaution the risk will be extremely slight.

I have asserted in previous bulletins and reports, as well as in addresses made at farmers' institutes, that the mere killing of the scales is not in itself a difficult matter. They can be killed during the winter with soap, kerosene, crude petroleum, gas or a number of other substances, but none of these will kill *all* the scales with any one application unless in very exceptional cases. The objection to all these winter applications is that they are expensive, and all of them must be used with some degree of care to avoid injury to the trees. The margin of safety is smallest with the kerosene, which has done some excellent work, but will undoubtedly injure a tree if carelessly used. Peach trees have been killed by it in a number of cases.

Whale-oil soap has been so long and so widely used that its effect is well known. It will injure fruit buds if applied early in the winter at a strength exceeding one pound in one gallon of water, but at this rate the material is only partly effective against the pernicious scale. In February the trees can be safely treated with two pounds in one gallon of water, and this is a very effective application against the scales, except where they are massed. Here the material will not penetrate below the outer layer, and the scales nearest the bark will escape. Nor is the mixture quite diffusive enough, and it does not get at the small individuals that have set close to the buds or in little crevices or under a protecting scale of bark. The soap may form a skin over these shelters, leaving the little half-grown creature, with its dense blackish scale, in safety. Yet on peach trees this soap has undoubtedly been the means of saving many a crop of fruit this season of 1899. It has been of benefit always, and as a rule has lost the scale more than a year's growth—that is, in the spring of 1899 there were very much fewer scales than in the spring of 1898. This subject of soap and the amount that has been sold in the State has been already referred to.

Crude petroleum, so far as experiments go, offers as large a margin of safety for winter application as does the whale-oil soap. I have tried it on all the common orchard fruits save cherry, and on a considerable number of trees, without in any instance, causing injury. The records of the experiment orchard should be referred to on this point, and also Bulletin No. 138, on "Crude Petroleum as an Insecticide."

The main advantages of this material are: it is penetrating, it is lasting, and, so far as experience has gone, it is harmless to the trees when used in a reasonable manner. It contains all the light oils like gasoline and kerosene, which quickly penetrate and spread over the surface, getting *under* the protections that the soap covers over. It also works its way through masses of scale, no matter how dense, and kills everything with which it comes into contact. I do not believe it possible for a scale to escape this material on a surface over which it is spread. The light oils evaporate quickly and leave a neutral, oily coating of vaseline, which remains for months, and proves fatal to all insects that attempt to set on it. The action of this material on fruit buds, if put on early in the season, is yet unknown; all applications on bearing trees of the undiluted material having been made in late winter or very early spring. The same lasting quality that makes the crude oil desirable as a winter application makes it objectionable in summer, because the vaseline residue chokes the leaves and causes them to drop. Individual trees painted with crude petroleum have been under observation for two years and have not shown traces of injury. An incidental advantage is that the material discolors the bark, making it readily visible and calling attention to defective applications. Crude petroleum will kill San

José scales whenever it is brought into direct contact with them in winter.

Winter work has its advantages and disadvantages: it is exceedingly effective if well done, but the scales are dormant, and very powerful and expensive mixtures must be used. I have omitted more than a mere reference to fumigation, partly because the subject is fully treated in another portion of this report and partly because I do not believe that, under present circumstances, the subject is likely to be of practical importance in New Jersey for some time to come; for orchard work, that is.

The scale does not become active very early in the season; it continues to breed rather feebly until late in November or early December, but it does not resume its geometrical progression until June 10th or 11th. Then the larvæ appear, increasing in numbers for several days, and this is the weak spot in the life cycle of the species.

In this larval stage the insect is easily killed by any contact poison that will kill plant lice; but it must be a *contact* poison and *must be brought into contact with them* to be effective. Kerosene or crude petroleum in a 10 per cent. mechanical mixture with water is perfectly effective; but the crude oil is barred because of its bad effect on foliage. Whale-oil soap, 1 pound in 4 gallons of water, will answer as well, and probably any good tobacco mixture would do equally effective work; but the kerosene in a 10 per cent. mixture is much the cheapest, and with an emulsion machine in good working order can be put on with the least trouble in preparation.

If an emulsion pump is not at hand, the old soap emulsion can be used instead, at the rate of one part emulsion to twelve parts of water. This is really much weaker than the 10 per cent. mechanical mixture, but the addition of the soap enhances the effect upon the leaves, and even at the strength given is apt to cause some injury to the foliage of peach trees. On apple it can be used one part emulsion to ten of water without danger, and this is probably true of other orchard trees save the thin-leafed plums.

The formula for kerosene emulsion has been frequently given, but may be again repeated for convenience:

Hard soap (Ivory), shaved fine	½ pound.
Boiling water	1 gallon.
Kerosene	3 gallons.

Dissolve the soap in the boiling water, and when completely mixed add the kerosene, which should also be a little warmed. Then churn briskly with a force pump for about ten minutes, when the whole will be pure white in color, of a creamy consistency and, when cool, will harden to a butter-like mass.

A bucket pump is a good thing to make this emulsion, the material being pumped from the pail and back into it again through the discharge nozzle, which should be small, so as to cause a thorough and violent mixture of oil and soapsuds until a homogeneous mass is formed.

Whale-oil soap may be used if desired, and is preferable; but as it carries more water than the hard soap, half more in weight should be taken. Soft water should be employed in making the emulsion if it can be obtained, and if not, it should be first made soft with borax. Hard water does not make a satisfactory emulsion and some waters simply will not make an emulsion at all.

All these mixtures will kill the crawling larvæ and the recent scales while yet in the white stage; but they will not penetrate the grey scale, nor, of course, anything older. The element of time, therefore, becomes of the very highest importance, and, to be most effective, the first spraying in the early part of the season must be made about June 15th—say between the 14th and 17th. This should kill everything then moving or recently set, and if the infestation is a bad one, six days later a second spraying would reach what had hatched since, and would also kill many more of the old scales, now not so closely attached to the bark. Possibly, all things considered, the kerosene emulsion made with whale-soil soap may be the best mixture for this application, for it is rather more penetrating and lasting than either of the others.

It has developed that after July 1st very few larvæ are found on the trees until early in August; hence this latter date is the period when weak mixtures may again be successfully used. But this time is subject to some change, for, if one or two early sprayings have been made, only the later sets can come to maturity; hence August 15th may be much nearer the mark. The orchardist who has to deal with this pernicious scale must, if he expects to be successful, learn to recognize the larva when it is moving about, and the appearance of the recent sets. This is the stage against which our summer applications must be directed, and these applications must be made just when they can be effective.

In this connection the record of the experiment orchard may be again referred to for proof that sometimes even this insect fails to do more than hold its own on individual trees, even when no treatment of any kind was given.

The scale can be controlled without much difficulty, *provided* the fruit-grower realizes his problem and prepares for it so long in advance that when the time comes machine, men and material are ready to go into the field at once. And this field must be free of anything that will interfere with the proper application of the insecticide. The scale is a factor that must be reckoned with by the fruit-grower whose orchard is infested, and he that does not will pay the penalty.

NATURAL ENEMIES.

The matter of natural enemies comes up constantly when discussing this species; but thus far nothing very important has been accomplished by them. Of this Californian species, introduced several years ago, nothing has been seen during the past year. Of native species I have observed several examples of *Exochomus tri-pustulatus* feeding on them, and as this is a very large "lady-bird" it might be a formidable enemy to the scales; but the species is rare thus far and I observed it only once, in small numbers.

The twice-stabbed lady-bird occurs in small numbers everywhere; but its natural checks, whatever they may be, have thus far prevented its multiplication to an extent sufficient to be of much use.

The little *Smilia* or *Pentilia misella* occurs in goodly numbers on infested trees and does much to keep down the scales, especially as it continues at work as long as the scale itself breeds. It may be found on the trees all winter; but just how early it becomes active in the spring has not yet been noted.

The little *Aphelinus* is also abundant everywhere, and on one occasion I was moved to make a close examination of a supposedly clean tree, because I noticed this little parasite skipping about on it.

Others of our lady-birds feed upon the larvæ; but I have not found anything that exercises any marked control over the increase of the species and nothing like a fungous disease.

The floridian disease introduced into the Roberts orchards has not spread notably, though it still exists there.

Recommendations.

Badly-infested trees should be winter-treated with crude petroleum, undiluted. It is preferable to do this rather than risk irregular work with an emulsion sprayer. Work should begin in January, and, if carried on steadily and thoroughly, an economic application of the undiluted material can be made. The only requirements are—thoroughness, so that every portion of the tree should be hit, and oil enough in the application to wet the entire surface completely to the dripping point. Small trees may be painted with a suitable brush, and this may be done after pruning, to lessen the amount of work; but too much oil should not be applied to raw wood; it might be better to treat first what is to be left on and cut back afterward.

Trees not treated in winter should be sprayed about June 15th with kerosene emulsion one part in water twelve parts, or with a 10 per cent. mechanical mixture of kerosene and water, or with whale-oil soap one pound in water four gallons. The emulsion is best, all things considered. The date, June 15th, is subject to modification, depending somewhat upon the season; it is best stated as five days after the larvæ are first observed crawling about in some numbers.

The actual date varies a little with the season; cold and wet may retard breeding a day or two, and an unusually dry, warm spell may hasten it as much; hence, actual observation is desirable and is easily made on some badly-infested tree on which the moving larvæ will become readily visible. A delay of more than five days is inadvisable because the first sets would then be entering the gray stage, in which they are safe from the weaker mixtures. Threatened rain should not prevent the application because the material acts promptly or not at all; but after a rain the trees should be allowed to dry, as otherwise the mixture, thinly applied on a wet surface, would become so much diluted as to be ineffective. Judgment is required here as elsewhere and the average date, June 15th, is only given as a point upon which actual observation should hinge, as far as possible.

So, August 1st to 5th for the second brood is also approximate only. The hatching period for this brood is much lengthened and the element of time is not quite so important. Assuming that no winter or June treatments have been made, two treatments in early August, at intervals of one week, are desirable. Either of the mixtures suggested for the June application may be used here.

The third brood comes in early September and is best marked by the sudden increase in moving larvæ that comes about September 10th. This is a good time for a somewhat strong mixture, assuming that none has been previously applied, and 15 to 20 per cent. kerosene in mechanical mixture, 1 part to 10 of emulsion or 1 pound of soap in 3 gallons of water, is indicated. This should be repeated during the first week of October, to kill off the larvæ that would be most likely to pass the winter in safety.

All these treatments are suggested on the idea that none others have been previously made that year, but there will rarely be a case when all of them will be required on any one tree. A tree treated with crude petroleum in winter should not, if the application was properly made, require another application that same year. If treatment was made in February or March no larvæ could set on any of the treated wood in June and live beyond the white stage. Except under unusual or abnormal conditions there could be no great number of larvæ present until the middle of September at least, and at that time any of the June mixtures could be used to obviate the necessity of a second winter application. As at this time the foliage is generally quite mature, the application may be very thorough. A better practice, unless the scales are very plentiful, is to wait until the following June and then attempt to destroy the brood as it makes a start.

If a June application is made on a badly-infested tree it should be followed by a second at a week's interval, and if these are thoroughly made, nothing more will be needed until the following winter unless it is preferred to rely upon the summer applications only, in which case a treatment in September is desirable.

If only a single application be made in June, a second during the first week of August will be desirable, to prevent the spotting of fruit.

Two drenching applications of 10 per cent. kerosene or its equivalent, thoroughly made in June and September, will suffice to keep the pernicious scale in check without winter applications at any time.

The effect of even a single thorough June spraying on the very badly-infested trees in the Riverton orchard was so marked that I have no doubt that had the work been kept up and a September spraying made the scales would have been reduced to a very low stage.

Finally.

The scale can be kept down to harmless numbers by the methods described, and at a reasonable cost.

The only uncertain factor in the problem is the fruit-grower himself; *if* he makes up his mind to control the insect, and *if* he gets ready to deal promptly and intelligently with the pest, he will succeed easily. The matter now rests entirely with him.

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